THE

ELECTRICAL REVIEW.

VOL. XXXV. DECEMBER 28, 1894. No. 892.

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SUBSCRIPTION RATES.—In *Great Britain*, Post Free, per Year, 19s. 6d. To all *other Countries*, per Year, £1 4s.

BINDING.—Subscribers' numbers bound, including case, for 4s. each volume.

CASES.—Cloth Cases for Binding can be had, price 2s. 6d. each.

FOREIGN AGENTS.—New York: D. VAN NOSTRAND, 23, Murray Street. *Paris:* VEUVE J. BOYVEAU, 22, Rue de la Banque. *Berlin:* ASHER & Co., 5, Unter den Linden.

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STREET BOXES AND TRANSFORMING SUB-STATIONS.

IN many respects the inquiry into the use of street transforming boxes has been distinctly satisfactory. The decision of the Board of Trade may not, however, be a final one: it may be even necessary to have a strict legal interpretation of what a street box is; but whatever may be the ultimate determination, we can rest assured that the Board of Trade will—compatible with public interests—see no great hardships imposed on the electrical industry. The inquiry may be taken as another proof of the good feeling that exists between the Board of Trade and the electrical industry. This Government Department has had to insist on a good many precautions which may have been irksome, but after the performance of its first great duty—the protection of the public—it is ever ready to help the furtherance of electricity. No industry has derived greater assistance from a Government department than the electrical industry has received at the hands of the Board of Trade.

Indeed, we may now look upon the Board of Trade as the patron of electricity, and so long as there is a desire on the part of electrical men to carry out their schemes without endangering public convenience, this Department will be found a willing coadjutor.

The principle which the Board of Trade was called upon to enunciate at the recent inquiry was of vast importance to electric lighting. Under the usual form of Provisional Order street boxes were, with certain restrictions, permitted in the public roadways. The question put in the form of a Xmas conundrum became, "when was a street box not a street box." The County Council said when it became a transforming sub-station. Now, the transforming sub-station, to use the inelegant but comprehensive phrase, has become part and parcel of all systems of alternating current distribution; it has been slowly evolved from former transforming methods, until it stands alone as the only practicable and economical method of dealing with an alternating current supply. The ability to use space under the streets for this purpose was of great importance to electrical companies; indeed, it is this alone which has made the sub-station possible. The County Council, however, sought to restrict the use of the streets for transforming purposes on various grounds; they held that it was dangerous to the public, and they maintained that it menaced their rights as guardians of the public highways. We are inclined to think that the latter was the determining cause of the appeal to the Board of Trade. The action of the County Council was based on eminently reasonable grounds, but there was a distinct weakness in the logical sequence of their arguments. The strongest point brought out by Mr. Bassett Hopkins on behalf of the County Council was that of interference with the public roadways in such a manner

that existing gas and water pipes might be injured, and the surface of the roads constantly meddled with.

It must be conceded that an undue multiplication of sub-stations might cause a good deal of inconvenience to the public, and might be harassing in other ways; but with a restricted use in fairly populous neighbourhoods, we cannot see that underground chambers would seriously militate against any interests. At any rate we cannot conceive of an electric lighting company provoking animosity by interfering with the rights and convenience of the public, and were they so disposed, we venture to think that the Board of Trade would have something to say on the matter.

There is no doubt that the County Council relied a good deal on the alleged danger to the public, Mr. Bassett Hopkins, dilating somewhat largely upon this phase of the question; but we really cannot accept their arguments seriously. If, as the County Council contended, there was danger in the streets from transformer sub-stations, how much greater the danger when placed in the basement of houses? Besides, as the County of London Company maintained, if their transformers happened to be in the basement of a house which was destroyed by fire, it would be within the bounds of possibility for a whole district to be plunged into darkness. Wherever the most suitable place for transformer sub-stations, the basement or cellar of a house is the most unfit. It is needless to speak of the difficulties there might be in obtaining cellars on private property, or the heavy rents that might be demanded. It would be, obviously, imposing a serious hardship on companies if they were to pay exorbitant sums for the exercise of a function which can be readily and safely accomplished in the street.

Considering all things, the decision of the Board of Trade, as foreshadowed by Sir Courtenay Boyle, that the electric lighting companies be allowed to build sub-stations under roadways, is a fair and common-sense interpretation of the clause in the provisional order. The County Council may not be at one with us, and, likely enough, they may have recourse to legal process, but we do not think that any judge would be inclined to depart from Sir Courtenay Boyle's rendering of the clause.

THE EDUCATION OF THE ELECTRICAL ENGINEER.

Although this important subject has been frequently discussed, yet by no means the last word has been said about it. We are glad, therefore, to see a contribution on the subject in our trans-Atlantic contemporary, the *Electrical Engineer*, which gives a very fair exposition, we take it, of the American view of the question. The writer points out that there are two diametrically-opposed views on this question. "One class, looking forward, insist upon the inculcation of general principles, leaving the filling in of specific details to be dictated by the necessities of the work finally engaged in. Another class, dwelling on the demands of the specific work, insist that the training in general principles be strongly supplemented by careful attention to specific details."

Much of this divergence of opinion, we think, arises from leaving out of account one important factor in all education, the person to be educated. The same course of education will not be the best in every case. That a liberal education in principles is best adapted to produce the first class electrical engineer we have no doubt. A man, who has learned at the university the art of learning, when he comes into the factory, will rapidly assimilate the details of any special branch of his profession, and will, moreover, have such a grasp of the principles as will enable him with ease to cope with new situations when they arise. On the other hand, there are many who enter the electrical engineering profession who have not the time or the means of obtaining the best mathematical, physical, and chemical education attainable at the universities and technical schools. Even these, however, had better devote their limited time to a thorough study of as much as they can learn of the fundamental sciences of electrotechnics. Special technical training frequently turns out, in after life, to have been only so much misdirected effort.

It has been a favourite notion with many authorities that the education of the electrical engineer should be nine-tenths mechanical. The writer in our contemporary is of opinion that the day for this kind of training is past. "The mechanical proportions and relations in the design of electrical apparatus have reached a point of somewhat general agreement. The mechanical considerations in electrical design are now rather secondary to the electrical conditions in a given device." Doubtless there is a good deal to be said for this view. The improvements to be made in dynamos and other parts of electric installations will certainly in the future be more in the electrical than the mechanical part of their design.

It is also the opinion of this writer that in electrical colleges the chemistry, physics, and mathematics should be taught by men who themselves have first been trained for the electrical engineering profession, and subsequently specialised in their respective branches. With this, as a general principle, we do not agree. It would be much easier for a thoroughly accomplished mathematician to discover what part of mathematics is best adapted for the electrical student, than for the professional electrical engineer to acquire such a knowledge of mathematics as would be required by his most advanced students. Our own advice to the coming electrician is, generalise in the schools and specialise in the factory.

The Influence of Magnetism on Germination.

We have frequently alluded to experiments which have been made with magnetism on the germination of seeds, and have often regretted that accounts of such investigation which have been available have not contained quantitative data as to the strength of the magnetic field, &c. Had such data been given it might have been possible to account for the conflicting results which different observers have obtained when experimenting with the same seeds. In *Malpighia* vii. (1894), pp. 470—482, there is an account of some recent researches by G. Tolomei on the effects of magnetism on the germination of *Phaseolus vulgaris*. He found that a magnetic field of feeble intensity had no appreciable effect on the germination of the seeds, whilst a field of greater intensity caused more or less increased rapidity of growth in proportion to the proximity of the growing seeds to the point of greatest magnetic intensity. Young plants he found to be diamagnetic. We are sufficiently grateful for such distinctions as *feeble*, *greater*, and *greatest* intensity; but when will these gentlemen, who are so interested in the effect of magnetism and electricity in plant life, be kind enough to accompany their results with quantitative data which may be made to convey something like an accurate notion of the conditions of experiment?

PRESENT AND PROSPECTIVE DEVELOPMENT OF ELECTRIC TRAMWAYS.*

(Concluded from page 705.)

Cars and their Equipments.—In the old horse car service the standard length of car body was 14 to 16 feet, and in open cars seven or eight benches. The added service done by the large electric roads brought about an increase in the length of cars, particularly in the closed cars. This was carried to an extreme, by increasing the length of the cars to 26 and 28-feet body, with double truck. We have had a reaction on that length, and we believe the best standard of car for heavy city traffic, and the one which will give the least wear and tear on the road bed, and also will enable the use of higher speed on suburban lines, is a car body from 20 to 24 feet in length—21 or 22 feet being the most desirable standard—and mounted on double trucks, with maximum traction on the driving wheels. Such a car body, with wide platforms—4 to 4½ feet—with entrances on one side, with wide double doors, fills best, we believe, the general requirements of such a service. There is a strong objection to the use of 19 or 20 feet car bodies on a single truck, with a 6½ to 7 feet wheel base, as has been done in a number of cases. There can be only one result from such an equipment, and that is a rapid destruction of the car body, and also the track. This pounding or destruction of the track on these single trucks has to a considerable extent been due to the weight of the cast-iron motors and their rigid mounting on the car axle. This difficulty has been greatly lessened by the introduction of steel motors of about half the weight, and the supporting of them by springs.

Open cars may be treated in a similar manner. Generally these open cars are used on a single truck; but if of excessive length, a double truck should be used. The trucks generally used we have partially treated of in describing the car bodies. To a car body 17 or 18 feet in length, a 4-wheel truck with a wheel base 6½ to 7 feet, increased as much as the curves which exist on the line will permit, is the standard where that length of car body is used. The general diameter of the wheels now used is about 33 inches, and we have many forms of heavy-built forged frames or steel pressed frames, with every possible arrangement of the spring base which can be devised to overcome the natural tendency of the car body to teetering when partly filled with an unequally distributed load of passengers.

Motor Equipments.—The improvement in motors during the past seven years, since their first introduction, has been marvellous. The old 7½ or 10 horse-power motor was a thing of pity, poor in its design both mechanically and electrically, and a continual worry and trouble to keep it in operation and service, the fields and armatures burning out every day, and the repair account on them running from 3 to 6 cents per car mile operated. Now, if we turn to the present type of ironclad slotted armatures and waterproof motors, with normal horse-power capacity, in the general type of motors of 25 horse-power, making equipment per car 50 horse-power, and built for any speed which is practicable on the service for which they are to be used, with a depreciation, wear and tear, less than almost any other type of power machinery, we have, it seems, attained a commercial stage and development in this motor which it will be hard to excel. These motors are now equal to almost anything to which they may be put. Their capacity, economy, and power are brought to a high stage of development, and their economical controlling and handling is managed by a controller stand which gives various combinations and arrangements of the motor fields and armature, which gives us complete control over the current under different conditions of service, and gives us an economy in current consumption which is away beyond the expectations of a few years ago.

Power House.—From the mechanical engineer's standpoint, probably the most interesting part of the equipment of the electric tramway is the power house, and therefore we will try to give you a more careful and detailed description of its present development and arrangement. The one central idea of electrical engineers, in the early electric light and power station work, was to have them located in the centre of the system, regardless of all other local conditions and requirements. Experience has shown us, in the broad treatment from an electrical and mechanical engineer's standpoint, that we want to take into careful consideration not only the electrical requirements as to the distribution of power, but also the possibilities of economical generation of that power from a steam engineering standpoint; therefore we give careful consideration at present to this matter. The general requirements are that a power station of any size or capacity should be so located as to generate, under the most economical conditions, the power which is to be used in the utilisation of electricity, and the location to be such that the obtaining and handling of coal and water shall be at the lowest obtainable net cost. The capacity of the station should take into consideration the present requirements and immediate future expectations as far as can be foreseen, and as far as the resources of the company will permit on a commercial scale, and without depending too much on future prosperity.

The general basis of calculation of the horse-power required for a tramway system must take into consideration the local conditions of service, grades, curves, &c., but, in general, 15 to 25 horse-power per car equipment in use on the road is the general limit of a well-designed station, which will take into consideration the conditions for the continuous service and operation of the plant. A road of 100 cars would therefore require about 2,000 horse-power, which horse-power should be divided into, say, four units of 500 horse-power each. The number of units in any station should be the fewest number which will give a safe and economical division of the units, and in a station of this kind four or five units, according to the service and conditions, should be the standard. In the past we have had to be guided largely by the capacity and size of generators it was possible to obtain, but this question is now eliminated, and any capacity of generator which the engineer may call for and feel necessary to meet the needs of his case, can be contracted for and built with a surety of success. Generators are now being built in this country up to 5,000 horse-power each. The general arrangement and character of power station building required for power plant is a well designed one-storey fireproof iron, brick, and stone structure, with trussed roof, travelling power crane in engine room, and convenient for the handling of coal, ashes, &c. which it may be possible to obtain. The method of connecting up the engine and generators in the early types of small generators was to belt them to small automatic engines, or else by countershafting. Both methods have their advantages and disadvantages. At present the tendency is large generators directly connected to the engine, whether automatic or Corliss, high, slow, or intermediate speed, such connection being made either by direct belting or directly mounting the generator on the engine shaft. The type of engine to be used on this service we have found must be equal in its requirements to that of rolling-mill service, capable of standing the heaviest strains in the variation of the load, and also to give desirable closeness in regulation under these heavy changes, in order that our generators may be balanced with one another. There is probably no service which has done more to develop the steam engine in the last few years than railway and power service. The Corliss engine is being better and more heavily built, and being made to regulate more closely than it did in the past. The automatic or high speed engine has been developed from a light, unmechanical single valve engine to a heavy, substantially built double valve engine giving good regulation and good service up to certain sizes; and for our larger units, we believe the alternate type will be an engine combining the advantages and uses of an automatic and Corliss engine, combining the advantages of both, and trying to avoid the disadvantages. Such an engine for general requirements we believe will preferably be a vertical, it giving better economy of space in large plants. As to the number of cylinders to be used in engines, it is generally acknowledged to-day that compound engines give the best results on railway work. Triple expansion, on account of the wide variation of load, have been found to be undesirable, and therefore cross or tandem condensing or non-condensing—preferably the former—are the standard to-day.

In boilers we have a wide range in style, size and capacity. The plain old horizontal return tubular, 16 or 17 feet long, with 3½ or 4-inch tubes, is still filling general requirements in a large number of cases in a satisfactory manner, where

* To be presented at the New York meeting (December, 1894) of the American Society of Mechanical Engineers, and forming part of Vol. xvi. of the *Transactions*.

real estate has not to be purchased at an excessive cost, and where the steam pressure does not exceed 125 lbs. Such a boiler, made with good material, with a butt strap joint, gives us good service. Where the conditions are such that we require water-tube or sectional boilers, we have a large variety to select from, many of them meeting our requirements, and giving good service; but a number of them we find are giving a good deal of trouble and bother in their care and maintenance, and also in not giving good dry steam.

The generators, as we have indicated, have been developed from small units to any size machine desired, and we have now a machine which, in its economy, durability, regulation, &c., cannot be excelled. A well built machine, with slotted armature, large commutator, carbon brushes, slow speed, and self-oiling bearings, requires a minimum of attendance to its good working. These are built for direct belting for a slow speed, or direct connection for the various types of engines operating from 75 to 150 revolutions, according to the size of the units or type of engine to which it is to be connected, and they are being built from 100 to 1,500 kilowatts capacity.

Car house.—A well built and well designed car house is of as much importance to such a system as its power house. Such a car house should be built to obtain minimum handling of cars, and afford good facilities for the care and repair of the cars in regular service, and also to give a storage capacity for the cars which are not in regular service. Such a car house should be a fire-proof structure in every respect, and afford ready access and egress for the cars. The general form of the structure, whether one or two storey, must be in accordance with the general conditions and requirements of each case, and be equipped with repair shops and repair pits, as well as paint shop, &c.

Operating Expenses and Cost of Equipment.—The old horse car road in large cities operated at a total cost of from 18 to 25 cents per car mile. One car mile is taken as the standard for operating expenses in our tramway service. The heaviest item in this operating expense was the question of power—that is, the care and maintenance of the horses, their feeding, and the depreciation of the same. The average life of a horse on a well operated tramway road is five to six years, and the number of horses required per car from eight to eleven, according to conditions and requirements. The cost of this power service was from 8 to 11 cents per car mile. This is where the electric road has made its heaviest gains in the reduction of operating expenses. This item is reduced in power surface to-day to a cost, under general conditions, ranging from 1 to 1½ cents per car mile. Is not this a marvellous gain in a few years, and does it not indicate and show the possibilites of the introduction of this power on this service? The relative proportion of operating expenses to earnings in the horse railway service was from 70 to 80 per cent. operating expenses to gross earnings. In electric service we have a considerable increase in our gross earnings over our old horse line, which increase runs from 25 to 50, and even 100 per cent. in some cases, and the operating expenses being 40 to 60 per cent. of the gross earnings. In this operating expense we include all the operating expenses of the road other than the fixed charges.

The cost of building and equipping an electric road is considerable. The last year or two has reduced this item to a considerable extent, especially on the electrical equipment, and has not only reduced the cost, but shows a great deal better equipment, and one which is going to show a much smaller depreciation than we had a few years ago. The standard price four years ago for an equipment of two 15-horse-power motors and the installation of them was $3,000 to $3,500. The price to-day for two 25-horse-power motors, which are much more superior to the former ones, is under $1,000. This gives us a total cost of a motor car, including car body, truck, motors, &c., of approximately $2,200. A single line of road-bed construction, with 90 lbs. girder rail, exclusive of any new pavement, but including taking up of the old track and replacing of old pavement, about $7,500 per mile of single track. This makes no allowance for special work. Overhead line construction for one mile of double track, with iron poles, feeders, &c., $4,000 to $5,000 per mile; with wooden poles, about $3,000 or $4,000 per mile. Steam and electric plant for direct-connected vertical compound condensing plant—for steam plant, $50 to $55 per horse-power, and the electrical, $20 to $25 per horse-power, making a total for steam and electric plant, $70 to $80 per horse-power. As a general summary, we have for the total cost of the equipment of the electric tram road—that is, the rebuilding of an old horse road—including power plant complete, buildings, car house, cars, equipment, track, and overhead construction, $20,000 to $25,000 per mile of single track, according to the varying conditions and requirements of different cases.

Conclusion.—Without going to extremes, I believe we may safely say that the electric tramways have more than met all the requirements, expectations, and agreements of even the most enthusiastic advocate during their early introduction, and when we look around us to-day, and see the universal introduction which they have met with in this country, and are now meeting with in all parts of the world, we can in a measure appreciate what has been done in this matter.

As to the future and the future possibilities of the tramway, not only for city and suburban traffic, but also to enter into competition for a large share of the steam railway service, it will see the introduction of electricity for many purposes and uses in this field. The limit of speed and power obtainable is only limited by the conditions and local requirements of this service. Theoretically, any speed is possible which is desirable to be obtained on any service, and the only limits are the resistance of the wind or air. As to the exact line which this development is going to take, it is hard to determine; but we believe for a number of years to come it will be a continuance of the present lines, with improvements in the general detail of construction.

The storage battery we have left out of consideration entirely, and we do not believe it is in a state that it needs to be considered commercially as yet.

Up to the present time in this service our development has been with direct or continuous current. There is no question but that, with the large improvements and modifications which are being made in alternating current apparatus, we may expect its introduction on the tramway service, especially for long-distance work.

In all this work the mechanical engineer has played, and will play, an important part, and the combined mechanical and electrical engineer is going to be, and has been, largely identified with the development of this line of work.

THE CAUSE OF THE CANNON STREET EXPLOSIONS OF NOVEMBER 10th.

By J. ENRIGHT.

A perusal of the evidence given at the inquiry, presided over by Major Cardew, into the circumstances attending these explosions, suggested the possibility of some gas other than coal gas being the explosive, and it occurred to me that the heat of the conductors might distil off from the material used to insulate them an explosive compound of some sort.

In order to ascertain whether or not this was the case, I cut up a piece of insulated stranded cable into lengths of about 1 inch, placed a number of them in a small flask and heated it in a Bunsen flame. Almost immediately a dark heavy vapour appeared to rise from the pieces, and soon filled the flask. On applying a light to its mouth, a heavy yellow flame, terminating in black smoke, arose. Every insulating material at hand, including vulcanite and paper, on being treated in the same way, yielded a combustible, and therefore an explosive vapour or gas. The temperature at which this production of explosive compound occurred was approximately fixed at between 300° and 400° C., by the fact that a vessel containing insulating material, and fixed in a bath of molten lead containing portions of unmelted lead was in a short time filled with a vapour which burned at the mouth of the vessel on applying a light.

I shall now briefly review the facts disclosed at the inquiry. In the first place several witnesses were distinctly asked if they smelt coal-gas, and each gave a reply in the negative. The testimony of the chief inspector of the gas company, who made careful tests for coal-gas in the vicinity of the explosions immediately after their occurrence, as well as on

the following day, is to the same effect, and to this must be added the evidence of the analyst, Mr. Wagner, who examined samples of air taken from the box in which one of the explosions occurred, and found no trace of coal-gas. The fact that Mr. Wagner took his specimen some nine days after the explosion does not lessen the value of his evidence, because it shows that the soil in the locality was not suffused with coal-gas, as might have been suspected.

But though nobody smelt coal-gas, many smelt India-rubber and tar. Freeman, an *employé* of Mr. Withers, smelt burnt India-rubber before the explosion. Mr. Withers himself smelt tar, and stated at the inquiry that his workpeople in the basement smelt burning tar and India-rubber for one hour before the explosions. Now, I suggest that an explosive gas was being distilled off from the insulating substances by the heated conductors during this period, and the hissing and rumbling sounds heard by some distinctly support this view. When sufficient gas had been produced to form with the limited supply of air in the culverts and boxes an explosive mixture, it was fired by an arc or an incandescent conductor.

Again, distinctly supporting, as I believe, the explanation of these explosions which I am urging is the evidence of Sergeant Cooper, who declared he saw dense smoke rising from the street box; of Alfred Neal, who saw smoke coming out of a hole in the pavement; of Constable Bradley, who saw dense columns of smoke and a flame two yards high; and of Hutchins, who also saw dense smoke. A coal-gas explosion does not give rise to dense smoke.

THE APPLICATION OF FUEL OIL TO STEAM GENERATORS.

Electrical Engineering recently contained an article on the above from the pen of Mr. C. O. Billow, who has for some time given attention to liquid fuel. He holds that as a fuel must only command such a price as is proper to its calorific power, it need not be feared that oil fuel will rise in price under an increased demand, beyond such as will still enable it to compete with coal, and, therefore, where oil is required to be used, it is quite safe to undertake the work necessary to use it with best economy. Originally oil burners were crude, and the results obtained were poor. Liquid fuel cannot be simply pitched into a furnace anyway. The furnace must be prepared for the fuel, and the fuel must be properly supplied to the furnace to secure economy. Now, we observe in the furnaces illustrated in the article under review, that there is a large amount of firebrick in the furnaces for oil combustion. A reasonable care is taken to maintain the burning oil in a refractory surrounding for some time before it is allowed to be cooled off by the boiler, and it occurs to us to say that were the same precautions taken with solid fuel, we should secure the same perfect combustion and economy. Solid fuel has so long held the field, that when it has been at last attempted to use liquid fuel, it has been found needful to apply it scientifically. Just as gas has for a century been burned in crude burners, and has only recently been provided with incandescent mantles, &c., because of the advent of the superior electric lamp, so coal, in the absence of other fuels, has been burned in the crudest of furnaces with a total disregard of the principles of combustion, and if oil does nothing else for us, we shall perhaps owe to it that coal will in future be more scientifically consumed without needless waste or smoke. Mr. Billow gives three analyses of fuels, viz., of anthracite, of bituminous coal, and of oil, as follows:—

Anthracite:—

Carbon	93 per cent.
Ash	7 „

Bituminous coal:—

Carbon	85 per cent.
Hydrogen	5 „
Ash and moisture	10 „

Fuel oil of specific gravity, 0·831 at 83° F.:—

Carbon	84·07 per cent.
Hydrogen	15·07 „
Sulphur...	0·44 „
Total	99·58 per cent.

Taking carbon to yield 14,544 heat units, and hydrogen 62,032 units when completely oxidised, we have the following theoretical power:—

Anthracite coal...	13,526 units.
Bituminous coal	15,465 „
Fuel oil...	21,575 „

He considers that these three fuels, when burned, can soon be made to yield 60, 55, and 77 per cent. of the above. The practical ratios would thus be 81, 85, and 166, and it has been found, indeed, in English practice, that liquid fuel is about equal to double its weight of coal.

With these ratios and the value in the market, it can soon be determined which is the cheaper fuel to use, and, granting a case for oil, it is shown how the furnace should be prepared to use it.

It is a mistake, when vapourising oil by a steam jet, to allow the heavy draught produced to run unchecked. It should be checked and baffled, as it is really forced unnaturally.

For this purpose, in an ordinary cylindrical underfired boiler, only a definite quantity of air is admitted by the ashpit door. The grate is lowered 10 inches, and upon it is built a series of brick flues drawing air from the ashpit, and delivering it just under the oil blower, near the furnace front, in a heated condition, having absorbed heat in passing through the above flues, which are kept hot by the furnace above. In place of the usual bridge is a cellular bridge of firebrick, against which the oil injector is directed. This affords an incandescent surface for large drops to settle on and be evaporated, and also as a check on the violent draught. Beyond this cellular bridge the flue bottom slopes downwards, and at the back of the boiler is a hanging bridge, which forms another check, and through which, if it needs it, a further supply of air is admitted before the gases turn up through the tubes, there being the space of the back down take in which further combustion can take place. Observe here a firebrick floor, or grate surface, a short arch of brick over the sprayer, the cellular bridge, the hanging brick bridge, and the brick sloping floor inclined behind the bridge; also a limited supply of air, and that hot. On the whole steam is to be preferred to air as the atomising agency, and about $3\frac{1}{3}$ per cent. of the boiler's steam production goes at the atomiser. Mr. Billow very properly disbelieves the idea of Admiral Selwyn that the hydrogen of the steam used acts as a fuel. Of course, this is impossible, but at the same time there appears to be some grounds to believe that steam has a beneficial action in a furnace, probably acting in some way as a carrier in promoting chemical reaction, like the nitric oxide in the leaden chamber of the acid factory. It is observed that there is no direct ratio between the oil atomised and the weight of steam used to atomise it, and each change of steam pressure requires to be met by a readjustment of the steam and oil valves. Hence the failure of automatic devices for regulation, for there is no regular ratio to go upon.

For water-tube boilers the same kind of grate is employed, but the bridge is hollowed out into a considerable concavity, and the upper part brought well forward to throw the flames amongst the first section of the water tubes. The oil sprayer points to about the middle of the length of the grate, thence the flame shoots forwards against the concavity of the bridge, where it meets with more air through a hollow or passage in the brickwork, and the high front between the injector and the lower row of tubes becomes the combustion chamber, it being essential to have a large chamber in which combustion may complete itself before it enters the cool tube space. Several other furnaces are described, but they are not of special interest to English readers, except that of the locomotive, which shows a firebox deprived of its grate, and with ash pan lined with firebrick. Oil is blown in just above the bottom ring, and against a brick-lined tube plate with a massive brick arch, which is also carried down the firebox sides. In this firebox there is much more brick than in Holden's compound system, and such a lined furnace should do well with solid fuel. Locomotives have been little or not at all fitted to use oil in America, though they are now fairly numerous in England, in Russia, and in South America.

Considering that America is the home of petroleum, this would appear strange if we did not recollect that American oil is controlled entirely by a gigantic monopoly, the Standard Oil Company, who fix the price of oil, regulate its production, and ruin all competitors. It is, therefore, scarcely

likely that the railways of America will put themselves under the heel of the Standard Oil Company. That oil is perfectly suited to locomotive work anyone who has travelled on one of Mr. Holden's engines cannot fail to admit. We have done so ourselves, and have rarely seen anything better to regulate or more efficient, the steam, which was not blowing off at Liverpool Street, beginning to blow at the safety valve before we had climbed the hill to Bethnal Green with 18 coaches of the Cambridge express.

In some tests made in Peru between coal and oil over a period of six months, the average train mile consumption of coal was 79·3 lbs. of coal, while in a sister engine with oil only, 33·55 lbs. of oil were used, being 42·3 per cent. of the weight of coal. Applying these figures to American engines, Mr. Billow finds that 846 lbs. of oil will do the work of 2,000 lbs. of coal. He quotes the case of a stationary "locomotive boiler," which for two months gave an evaporation of 16·45 from and at 212° per pound of Lima oil. In this boiler the oil was put in at the opposite end of the fire-box, and the firebrick arch also was reversed, while natural draught was relied on to draw the flames through the tubes. Similarly on a tug, where coal cost $12 a day, oil fuel cost $9 only, and makes no smoke.

All writers who write up the merits of oil lay stress on this smokelessness, and lapse into beautiful prophesies of the future as created by oil. Now there is just no ground for all this visionary writing. Mr. Billow himself admits a coal consumption of no less than 500,000,000 tons per annum, while of oil, the entire production if reduced to coal basis is only equivalent to 15,000,000 tons of coal per annum. Oil can, therefore, not supersede coal, nor can it, therefore, put an end to smoke. Oil is a smoky fuel unless burned in a suitable furnace. Coal has the same fault. As we must use coal, why not give equal attention to burning it in suitable furnaces? So far, says our author, no special design has been made of a steam generator to use oil fuel, though he does not anticipate any very great departure from the designs he gives. He rightly points out that a specially arranged oil burning furnace could not revert to coal if the oil supply were cut off.

This is a point of great importance, and it is just here that the Holden system, as used on the Great Eastern Railway, has such obvious advantages. To pass from oil to coal is a matter of not a moment of time. To revert to oil is simply a matter of burning the coal fire down below the level of the oil sprayers, and even this is only perhaps necessary for economy. It is not absolute.

Fuel oil is a bye product merely. It cannot be stored without expensive holders, and must be sold as made. This is looked on as a check against any cornering of the market or undue raising of the price.

It has recently been stated that in Germany an apparatus has been tried for burning coal dust. With the experience of coal dust explosions in mines, there is no reason but to suppose that coal can be burned like a liquid; but the trouble is, that some sort of stive chamber would be necessary in which to settle the dust, which would be intolerable if allowed to pass out of the chimney top. Even then, however, it would be found needful to use a brick-lined furnace; and, given such a furnace, coal could be used unground. Altogether, Mr. Billow's article is a very good *résumé* of the question of oil fuel and furnaces.

EXHIBITION AWARDS.

A matter of the greatest interest to that section of the trading public taking part in exhibitions, international and otherwise, has been brought to our notice. It is a matter which we consider demands greater watchfulness and discretion on the part of juries and others superintending the granting of awards for exhibits. The value of such awards is not the same in the estimation of all successful exhibitors; the chances of securing awards too often depends upon the amount of money spent in getting up an exhibit. Whatever their value, however, it is much to be deplored that there exists the possibility for those who have not received awards to publish it broadcast upon notepaper and in advertisements, without anyone for months attempting to check them, that they have been awarded a "First prize at Chicago, 1893," and "a gold medal at Antwerp, 1894," whereas the facts really are that they possess no award whatever from the Chicago 1894 Fair, and only received a silver medal from the Antwerp Exhibition. The firm guilty of this misrepresentation has branches in London and Germany.

The most amusing part of the affair, if there is any amusement in it at all, is the printing at the head of letter paper, what apparently purports to be *fac simile* reproductions of the original Chicago medals; but, as a matter of fact, the Chicago Exhibition authorities themselves had not received proofs of the design for the German awards at the date upon which the letter paper in question was printed; so how an exhibitor could obtain a copy we cannot quite perceive.

If the exhibition authorities, whose actions are thus misrepresented, have it in their power, and we should think they have, we trust they will come down upon the offenders. Competitive firms might take the matter up, as one company has already done.

GAS ENGINES AND ELECTRIC TRANSMISSION.

Mr. J. C. Henderson is a believer in the transmission of electricity from the coal mines, where he would generate it by means of gas engines, recognising that the gas engine is one of the more economical heat engines, and will, under favourable conditions, produce a horse-power hour for about ¾ lb. of fuel, which he somewhat erroneously sets down as just half the best steam engine performance. Seeing that the ¾ lb. was an expectation, and that its double of 1½ lb. relates to the past tense of the steam engine, the comparison is a little strained. However, Mr. Henderson is not too enthusiastic, for he states that as between electrical transmission and the carriage of solid fuel, the former has got to beat the hard fact of the power of the railroads to carry 250,000 horse-power hours—the equivalent of 100 tons of coal—at a very low cost from the mine to the point of use. While we quite agree with the statement that gas and oil engines are very perfect forms of heat engine as compared with the steam engine, we cannot overlook the fact that they have been perfected so quickly because of the many years' teaching of the steam engine, nor must it be overlooked that the steam engine has not reached finality. The steam producing part of the engine is far from perfect, and even if we grant that the limit of pressure has now been reached, we cannot grant that the generation of this pressure has touched its lowest limit of cost. That there has been very little improvement in the boiler for 100 years outside mere mechanical construction we may admit, but we do not admit that improvement is therefore impossible. All would-be boiler improvers have been moving upon entirely wrong lines. Their one aim has been to snatch the heat away from the furnace as quickly as generated, lest it should somehow disappear, and in straining at this gnat they have swallowed the whole camel of non-combustion. Not a thought have they given to securing perfect combustion, and the writer has seen but one boiler in which combustion was first taken into account, and heat transference to the water made a separate affair. There is still a large margin for economy between the calorific power of fuel and its hitherto obtained duty. For some time to come the steam engine will hold its own as a power, and as it becomes more perfect, the great objection to the use of fuel in city limits, viz., smoke will disappear, and any arguments in favour of long distance electrical transmission of energy will require to be based entirely upon economic facts; setting the economy of large generating stations and cheap fuel in favour of the idea as against the counteracting heavy expenses in constructive interest charges of the line, the loss incident to the transmission, which even the best of insulation cannot wholly eliminate, and which must increase with every mile of distance, and the possibly smaller future charges for carriage of stored energy in the solid.

Mr. Henderson refers to oil engines. So far, the world's production of oil fuel has not been great, and it does not

occur to us that if oil is produced in greater quantity it will, so far as regards London, Manchester, Liverpool, Glasgow, Bristol, or any of our large seaports, have any great influence in favour of long distance electrical transmission. Either from America or from the Caspian, or from any future discovered petroleum region, oil must be shipped to us, and any influence it may have will all tend to the establishment of power stations upon, shall we say, the Essex Marshes, Chatmoss, or other half desolate areas near big cities. The present outlook is indeed rather favourable to the comparatively short distance transmission of energy, excepting in case of water-power as the original source, which cannot well be bodily transferred. Recently, within quite a few years, we have seen the mistake made by all our northern railroads of duplicating their lines, in order to cope with increased traffic. All such duplication has been carried out to the highest Board of Trade requirements for passenger traffic. Should the continued growth of traffic warrant a further extension in mileage in the future, it would seem to be wisdom to build upon the American plan, and use the new cheap line simply for goods trains. This would cheapen the cost of coal conveyance, and do away with the necessity of running fast coal trains. The Americans carry such traffic at very low rates, and at equally low speeds upon very poor lines, and it is only lately that the demand there for higher speeds has forced them to improve their roads. Similarly here, the demand for cheaper freight should be met in the future by cheaper roads, and all this will tell against long distance electrical lines of transmission.

It is not as though electricity were a power from other sources than fuel. The whole of the saving, excepting, of course, where it is sought to use water-power, must be made practically out of the item of carriage, with a counterbalancing smaller or greater leakage of current as a set-off. The æsthetic side of the question is becoming of less moment as fuel becomes better utilised. If some of the enthusiasts would expend a part of their energy in showing how it would pay existing electric companies to extend their mains into suburban highways, not to name bye-ways, we fancy they would better serve both the future of electricity and the health and comfort of their fellows. Electricity at present—Mr. Preece to the contrary, notwithstanding—is the light of the rich man and the shop-keeper. No one has yet made an attempt to give the poor man even the opportunity to make the comparison. Until this is done, it is folly to dream of more costly schemes. There ought to be money in both electric lighting and heating for cooking purposes. It requires only a moment's thought to appreciate that a turn of a switch in one's room would light the fire below and also boil the kettle, making a house comfortable for the first riser, saving 30 or 40 minutes of time, and setting the householder much freer of the domestic tyrant.

There is no end to the possibilities of electricity. Mere lighting is, or ought to be, an incident only. Allowing 1,000 watts to the horse-power, the cost of one-thirtieth of a horse-power hour will run about a fifth of a penny, and this would pump a day's supply of water 50 feet in an average household. The Lambeth Water Company charge nearly 3d. per day. It is thus clear that in this one item alone householders, who are within reach of the water bearing strata beneath, would effect an economy, and keep dilute sewage out of their houses. We are all crying out for day loads, and yet take no steps to secure them. We profess a faith in electricity, and refuse to carry it to consumers' doors, entirely overlooking the well-known fact that people do not go to buy what they know is not for sale, but will purchase anything if it is put within their reach.

IS THERE A SOLUTION OF THE ELECTRIC CONDUIT RAILWAY PROBLEM?

The *Electrical Engineer* (New York) abstracts a lecture by Joseph Sachs before the New York Electrical Society, Columbia College, dealing with the subject of conduits for electrical lines. The lecturer seems to be of opinion that the various forms of open slot conduit have many disadvantages in size and arrangement, and appear to have been designed for cheapness, to compete with the trolley system, rather than for efficiency.

The Blackpool conduit is referred to as one on a line that is paying a dividend, so also is the Siemens-Halske, which, at Buda-Pesth, has worked since 1889 with 60 cars on a length of six miles. In this conduit the groove is in the rail itself, and the wheel has a central flange, and there are two wires in the conduit, which is bedded in cement concrete. It is doubted if such a conduit, however, would work in America.

The Love conduit is on trial at Chicago. This is a large conduit, carries the wires high, and there is a removable cover which can be taken up to get at the wire.

In the Van Depoele conduit the wire is protected by flexible lips, to be opened by the car plow, and closing after this has passed; but the difficulty with all these is that we are still lacking a sufficiently permanent elastic material. In the Lineff system the contact rail lies exposed upon the surface. It is in sections, 6 to 10 feet long, laid upon the conduit, which is beneath, and closed. The conductor in the conduit is flexible, and carries a strip of iron. There is a magnet on the car which lifts this flexible strip, and makes contact with each section of rail as the car comes upon it.

Mr. Van Depoele also devised a surface contact system on somewhat similar lines, but in this case a magnet on the car pulls along a little trolley running in the conduit. This little trolley makes the contact as it runs between the true conductor in the conduit and the sections of the surface contacts. In the Zell and other systems there is special provision for drainage and dirt, and sewer connections. The Zell conduit indeed appears, on the face of it, exceedingly good. Nothing, however, is said as yet as to the faults developed in working of this or any other system, but that of the new extension of the Ninth Avenue cable road of New York City is quite a large and complicated affair, with manholes, &c. This New York conduit does not strike us as particularly calculated to avoid drip on the conductors, which are directly below the most likely place from which the wet from the street will drip when it has crept through the slot and along the horizontal surface. There is, in fact, no provision to compel the drip to fall from a single drip edge.

Indeed, few examples, show a sufficient appreciation of the fact that rain and mud must flow freely into the conduit, and should as freely get away.

REVIEWS.

The Electric Current, How produced and how used. By R. Mullineux Walmsley, D.Sc. (Lond.) &c. London, Paris, and Melbourne: Cassell & Company, Limited.

This is an electrical engineering text book of the commonest type, with all the old familiar illustrations to be found in most standard works on electricity and magnetism. Throughout the work, modern apparatus and methods are lightly touched upon; the design of dynamo magnets is treated and illustrated principally in the manner and by figures from Prof. S. P. Thompson's works.

Woolrich's early electroplating dynamo is described and illustrated, and is of interest; but what earthly use there can be for a reproduction of the descriptions and illustrations of old obsolete machinery, like the Alliance and Wilde's, we cannot conceive.

About 24 pages are devoted to the usual unsatisfactory treatment of thermal production of electricity, without adding anything new except a description of a radio-micrometer.

Part II.—The laws of the electric current and the chapters on measurements, are the best in the book.

Part III.—The applications of the electric current is not up to date on important matters, and contains far too much old material. In arc lamps we are shown the ancient Foucault clockwork lamp, the Jablochkoff candle, and the evergreen Brush arc lamp. The author is altogether wrong about the production of a workable lamp. He says: "To produce a workable arc lamp requires little or no originality, and calls for the display of only a moderate amount of mechanical skill." Well, many skilled electricians and mechanics, and sometimes both combined, have endeavoured to produce a workable arc lamp, and yet, as every practical engineer

knows, the very best one to be bought leaves much room for improvement; not one is entirely satisfactory after all. Simply because hundreds of supposed inventors have produced thousands of designs for arc lamps, is no proof whatever that the production of a really workable lamp is an easy matter; the scarcity of such workable lamps is proof to the contrary. A modern lamp is not shown and described, the reader is referred to other works for information regarding them, and old acquaintances of our boyhood are foisted upon us instead.

Polyphase currents are dismissed in four pages, and polyphase motors in two. A few pages are devoted to "electric waves," the author regretting that he had to cut this subject short. He had better have cut it out altogether, for all there is in it is of no use to a student. In electromotors the ancient and obsolete motor of Jacobi comes first, of course; no writer can resist the temptation to lug in this motor. Its study must be considered very instructive.

Finally in railway motors a design is illustrated said to be designed by Edison, see page 701. To be correct it was made by the Edison Company, but they did not claim the design either for Edison or themselves, but openly admitted the source from which it came. The teacher of electrical engineering ought not to fall into the popular error of ascribing to Edison the invention of everything in electric lamps, dynamos, and motors. The book has about 750 pages, and with the exceptions here referred to, will be found of some value to students in the elementary stages of electrical engineering.

Electric Light and Power Distribution. By W. Perren Maycock, M.I.E.E. London: Whittaker & Co.

This work is a combination of Part I., II., and III., previously issued separately and formerly reviewed by us. Part I. we admire as much as ever; it is still the best elementary treatise on the science of the subject. In a future edition we would recommend leaving out the illustration of a cast-iron box with an eye-bolt on it used to represent an "electric light condenser;" the case containing a condenser has nothing educational about it. Part II. is largely illustrated from trade catalogues; in this respect it has not been improved. About 40 pages of continuous current dynamo illustrations is too much, especially as most of them are of such poor designs that they are now obsolete; one or two good illustrations at most is all that is necessary.

The scientific part of this chapter is good, except that portion of it devoted to arc lamps. The Brockie-Pell, Brush, and Gülcher lamps are illustrated and described, but the student wants more than that: he wants to know the science of arc lamp construction, and the elementary guiding principles.

Part III. deals with accumulators, transformers, central stations, mains, and miscellaneous matters. Fig. 221 is not a good example to set before students as a modern transformer, and the statement that transformers work with an efficiency of 98 and 99 per cent. must be taken *cum grano salis*. The greatest achievement of electrical engineering in the world is said to be the Liverpool Overhead Electric Railway, but where the greatness comes in is not explained. It is said to be no less than six miles long, and is likely to be lengthened to the great extent of another three miles. Although we take exception to these points, the book contains all that is necessary for the elementary student, and is to be recommended. What we protest against is the filling up of space with mere illustrations of machines and apparatus now, for most part, obsolete; they are not instructive unless used for the purpose of pointing out their defects and faults in design; in no case is this done. If it were done, there would very soon be much less of the catalogue about text books.

Practical Electric Bell Fitting. By F. C. Allsop. Fifth Edition, Revised and Enlarged. London: E. & F. N. Spon, 125, Strand.

The demand for a fifth edition of this useful book is a sufficient evidence of its merit. Revisions and additions have been made, but we notice a statement on page 112 which certainly requires alteration—the current necessary to ring a bell is stated to be from ½ to 3 ampères; they must be exceedingly badly constructed patterns which would require such currents as these to work them well.

The Slide Rule. By C. N. Pickworth, Wh.Sc. London: Emmott & Co., Limited, 56 and 57, Fleet Street.

The advantages of slide rules is but very imperfectly appreciated in this country; the idea still prevails that calculations effected by its use are both difficult of execution and very roughly approximate. Such notions are incorrect, to say the least, and are but slowly being got rid of. It is possible that the notions have partly arisen from the very uninviting appearance of illustrations of slide rules which certainly do not give one an idea of accuracy, the engravings being very roughly done; at the same time it is difficult, or rather impossible, to give an adequate explanation of the immense amount of work which can be done with even a small rule, without a great deal of unattractive looking printed matter. The manual by Mr. Pickworth deals chiefly with the Gravêt or Mannheim type, and, taking it altogether, the writer has done his work well, the examples selected being fair cases of those met with in general practice.

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*Calendar for Electro-Technicists,** 1895. Issued by F. Uppenborn, engineer, of Munich. Vol. xii. Munich and Leipzig: Oldenbourg, 1895.

This work, which is wonderfully replete with information of value to electricians, appears in two parts. Part I. is neatly bound in the form of a pocket-book, whilst Part II. is merely in a paper cover.

The book commences with an almanac of mediæval style, in which each day is decorated not with the dates of great discoveries in electricity and the allied sciences, or with the birth and death days of illustrious inventors, but with the names of saints who may have existed or who may be mythological. At the end of the volume comes another almanac giving the dates of the moon's phases. At the end of the former almanac follows a list of the dates of electric inventions.

The first section of the book is concerned with mathematics, including tables of weights and measures. We have still separate tables for British and Russian standards. We may venture to say that had the metric system not been encumbered by the polysyllabic Græco-Latin names which its French authors imposed upon it, it would long ago have been accepted in the United Kingdom. Under the heading, "Physics," we find tables and laws pertaining to mechanics, magnetism and electricity. There is an explanation of hysteresis, and an account of the laws of Ohm, Kirchhoff, and Joule.

Section III. enters upon the main subject of the book, electro-technics. Of this a large portion is devoted to an account of the principal establishments for the manufacture of electro-technical appliances, all except two being in Germany.

The construction and verification of lightning conductors are very fully dealt with. The reader is cautioned that a determination of the resistance is not in itself sufficient to prove the satisfactory condition of a lightning conductor. Iron is not recommended for the conduction, as it withdraws the self-induction from calculation. The combination of iron and copper, whether by soldering or other methods, is justly condemned as involving the corrosion of the iron. In the examination of a lightning conductor the earth is too often overlooked, the observer forgetting that if it is bad the entire installation is simply a source of danger. As far as the mere protection of life and property is concerned, there is less need of lightning-rods in Britain than in Central Europe, not to speak of India or Africa. The chief danger of a thunderstorm with us is the fall of temperature which it mostly involves. To lose ten days or a fortnight out of our short summer is a serious affair for all kinds of crops. Hence if our electricians could devise some method of dispersing thunderstorms or preventing them from forming, they would confer an incalculable boon on agriculture.

The section:—"Matter of general utility," includes a mass of matter generally useful. We find here, *e.g.*, a notice of the German postal service, and an account of the meagre benefit conferred by the vaunted "International Postal

* *Kalender für Elektrotechniker.*

Union," which has, we fear, blocked the way to a thorough postal reform.

In addition to ordinary telegrams, the German empire admits of urgent telegrams for which there is charged three times the price of an ordinary telegram, and which, in case of need, take precedence of common messages.

There are tables of fees for engineering and architectural work, plans, reports, estimates, &c. Then follows a comprehensive table of the latitudes, longitudes, and altitudes, of the most important places, their mean annual temperatures, and the gravitation at each. Lastly comes a table of the symbols used in the strictly electrical chapters of the book.

Part II. is of a supplemental character. Part I. is devoted to the higher mathematics, in as far as practically useful. Then follow physics. Here we have a section on "Areometry." This is the German term for what we less logically call hydrometry, that is the approximate determination of the specific gravity of liquids by means of a graduated floating instrument. Of such instruments there are unfortunately various forms, both for liquids heavier and lighter than water. We find here the scales of Twaddle, Gay-Lussac, Brix, Beck, Beaumé, and the Dutch scale placed along with the true specific gravities. It is to be remarked that the areometers or hydrometers of Brix are graduated at 12½° of Reaumur's thermometer, those of Beck at 10°, Beaumé at 14°, and the Dutch scale at 10° R. Of these scales the most objectionable is that of Beaumé, in as far as different authorities mostly disagree concerning the value of its degrees. The instruments of Gay-Lussac, Brix, Beck (for heavy liquids), and the Dutch scale are fortunately not in use in Britain. It is to be regretted that the Beaumé instrument is still almost universally employed on the European continent and in America.

Hydrometry, in this book, as in general in German technical works, is the accepted term for determining the flow of water in streams, canals, &c.

The last section of Part II. contains an abstract of the German patent law, of the regulations for verifying resistances, ammeters, voltmeters, galvanometers, and other electro-technical appliances.

The laws for the insurance of workmen against accidents and of injuries to health are doubtless intelligible to a German lawyer. It seems that workmen in certain employments are obliged to pay a certain sum on every pay day into a common fund to which the employer is bound to add one-third from his own resources. We find here no stipulations as to the sanitary character of factories and workshops, though we know that such exist and that they are not deficient in strictness.

A Text-Book of Mechanical Engineering. By W. J. Lineham. London: Chapman & Hall, 1894.

The title of this book is so ambitious, that it is quite an agreeable disappointment on opening it to find that it accomplishes so much. Mechanical engineering, in itself, is so wide a field, that any one writer cannot hope to cover the ground. In fact, one might hand every page of the book to an expert in the subject dealt with on that page, and receive a volume written on each subject. For all that, Mr. Lineham's book is a really good production. It is not simply a re-hash of so many trade catalogues, though necessarily the makers of tools have been drawn upon for particulars and illustrations of special machines, but a genuinely original work founded upon practice, and dealing with actual workshop examples. Such a work put into the hands of an apprentice freshly entering on his work would be of very great service to him. In the present writer's early days there was no book that could even pretend to fill the place of this. There were books on special details, such as valve gearing, but none of the widely embracing character of the one before us. It were strange, indeed, not to detect some errors in so wide a field, and some few we note. On page 5 it is stated that *green sand* is the geological name of a sand of fine texture. This is how the author derives the foundry name of green sand, but surely he is in error here. The sand of the foundry is termed green because it is in a slightly moist state, and therein differs from the so-called dry sand. A casting is termed a green sand or a dry sand casting, according as the metal is run into the undried or dried mould; but we venture to say there is no geological green sand used in north country foundries, for the geological green sand does not exist further north-west of London than in the counties of Cambridge and Bedford, and then the green sand of the geologist may be exceedingly fine, as at Wrotham, in Kent; coarse, as at Leighton Buzzard; it may be yellow where oxidised, as at Sandy, or green, as seen in a deep well when newly exposed. It varies from being a dirty, sandy clay, to the hardest and toughest rock of South-East England—to wit, the Kentish rag.

Then, speaking of gas engines, it is said ignition tubes will last a fortnight only. This ignores the modern tubes, which will last, we believe, many months.

Of toothed wheels, the old-fashioned ordinary proportions are given, with simply a remark that it is proposed that the tooth length be shortened. Of this it is objected that fewer than two pairs *may* only be in contact at once. Now, so long as the tooth length is sufficient for one pair to come into contact, if the pitch be even before the previous pair cease contact, that is all that need be considered on the score of length in respect to the question of numbers in contact. In large gears of old proportions there may be seen an arc of mesh some 2 feet long, whereas a fourth of the length is ample. Too early contact, especially before the line of centres, is apt to give rise to shock and friction. The most carefully moulded teeth are apt to be a little out of truth, and in long teeth not only is such want of truth more marked, but it causes undue pressure at the worst position of the teeth, *i.e.*, just when first meshing, and shock acts with far greater severity on the long teeth. Then, with all deference to Mr. Lineham, though we admit the excellence of modern machine-moulded teeth, we would say that truer teeth can be cast from a machine-cut wooden pattern than can be moulded. The mistake in most wheel patterns is that they are made new and good. The best wheel patterns are those which, after years of storing, are overhauled, the bodies wedged up tight, and new teeth put in and cut. But though these are facts, no one would now make a wheel pattern for an odd pair, or even a few pairs of wheels. We do, however, think that it is to long and badly pitched teeth that it came about that toothed gearing was discredited, and gave way to belts and ropes, with all their accompanying increase of friction.

In dealing with the operations of the workshop, the author has selected a steam engine as a machine in which are comprised practically all operations. Turning, boring, slotting, planing, all find something to do upon the engine. Squaring off, marking off, drilling, forging, all find a place in the engine, which is, at the same time, more or less familiar to all engineers, a fact rendering any description of details or of operation upon a named detail easy to understand as compared, say, with a similar attempt to deal with a less general machine, such as a printing press or a spinning frame, familiar only to a special class, or locally. The illustrations are not mere pedantic pictures, as so usual, but are from actual practice, and this is pretty well carried out throughout the whole book; the locomotive illustrated being the celebrated North Eastern compound, so creditably known for its performance, the marine engines being those of the Iberia. Most of the folding plates are made to lie wholly outside the book for convenience in reference to the descriptive matter. So far as is possible, one letter in the formulæ has been retained for one signification, and Part II. commences with an alphabetical synopsis of all letters and signs used throughout this part, which is devoted to theory and examples, few of them standing for two purposes. The mathematics of the volume have been simplified as far as ever possible. Indeed, the book is a good example of what may be done without mathematics. Few technical writers seem to write without flying off into mathematics to a degree wholly needless. That sure sign of the made-up book—the perspective illustration of a machine or an engine, is, happily, quite wanting. All the illustrations are genuine drawings. Necessarily each subject dealt with has required brief treatment, the available space being, of course, limited, but what is said is good and to the point, and the author, where not himself, perhaps, specially familiar with any branch of his subject, has been fortunate in drawing upon a good authority, and so far as one can read the book more critically in light of one's own experience, it is very generally correct, as one recognises the correctness of the source of the information.

While, therefore, it is open to criticism as perhaps a little

too ambitious in covering too wide a field, this is certainly the best student's manual that has appeared on mechanical engineering, and all that is implied thereby in knowledge not of tools only, and the practice of the mere workman, but also in design, and in a fair knowledge of thermo-dynamics and physics; prime movers, both steam, gas and water, receiving attention.

It is a book we do not hesitate to recommend.

THE UTILISATION OF WIND POWER.

By RANKIN KENNEDY.

(*Concluded from page* 736.)

SINCE last week, some interesting information has come to hand in the *Engineering Magazine* in an article on windmills on the Lewis system. The interesting points are referred to below.

The same windmill may be used in any system. Lieut. Lewis, in his article, states that there are no fewer than 1,000,000 windmills in use in the United States. Twenty firms are engaged in their manufacture, and their combined sales exceed 100,000 mills a year.

A plant has been erected in America, on the Lewis system, at Marblehead, Mass., U.S.A. This plant displaced a steam engine plant; it consists of an "Eclipse windmill," with a wooden wheel 20 feet in diameter on a tower 75 feet high. This mill drives a dynamo of 2 kilowatts output at 1,200 revolutions, and is wound on the "Lewis system" for speeds varying between 750 and 1,500 revolutions per minute; but it has been found that this size of mill was better suited for a 3-kilowatt dynamo.

The Lewis device consists in winding the dynamo with a reversed main coil, so that as the current rises the field is weakened, and *vice versâ*; when the current falls the field strength increases.

This device compensates for variations in speed within the limits indicated in the speeds given in the above paragraph.

The dynamo feeds into 46 storage cells of 200 ampere-hours capacity, and 90-volt lamps are used.

Comparing the steam plant and this wind plant, we have figures given as follows: steam plant for 75 lights—original cost £200—depreciation £20, interest £10, attendance £15, operating expenses for six months £20; total yearly cost £65.

Windmill plant, supplying 127 lights, original cost £360; depreciation on mill 5 per cent., and on electrical plant 10 per cent., £26; interest £18, attendance £4, operating expenses £2, total yearly cost £50.

In the case of steam-power the average cost is about 16s. per lamp per year, with wind plant, 8s. per lamp per year.

The following table, showing the actual useful horse-power developed by windmills of different sizes, is the result of experiments, made with wooden wheels, driving a differentially wound dynamo. It will be found to be a moderate, though fairly accurate one, for the best mills of this class. For the best steel mills the figures should be increased 20 per cent.

Diameter of wheel.	Windmill. Actual useful horse-power developed.						
	8-m. wind.	10-m. wind.	12-m. wind.	16-m. wind.	20-m. wind.	25-m. wind.	30-m. wind.
12-foot wheel ...	0	$\frac{1}{8}$	$\frac{1}{4}$	$\frac{1}{2}$	1	$1\frac{3}{8}$	2
14 „ ...	0	$\frac{1}{4}$	$\frac{3}{8}$	1	$1\frac{3}{4}$	$2\frac{1}{2}$	3
16 „ ...	$\frac{1}{8}$	$\frac{3}{8}$	$\frac{5}{8}$	$1\frac{1}{2}$	$2\frac{1}{4}$	$3\frac{1}{4}$	4
18 „ ...	$\frac{1}{8}$	$\frac{5}{8}$	$1\frac{1}{4}$	2	3	4	5
20 „ ...	$\frac{3}{4}$	$1\frac{1}{4}$	2	3	4	$5\frac{1}{2}$	7
25 „ ...	$1\frac{1}{4}$	$1\frac{3}{4}$	3	$4\frac{1}{2}$	6	8	10
30 „ ...	2	3	4	$5\frac{1}{2}$	7	9	12
35 „ ...	3	4	$5\frac{1}{4}$	$6\frac{3}{4}$	$8\frac{1}{4}$	$10\frac{1}{2}$	14

By "useful horse-power" is meant that actually applied to the shaft of the armature, as shown by the voltmeter and ammeter, allowing 500 watts per horse-power.

This table is made up by Lieut. Lewis.

Now, in this country, Prof. Blyth has experimented also with windmills and storage batteries, and others have proposed schemes from time to time, but all of them have the trouble with the varying speeds.

Whatever device may be adopted to adjust for varying speeds, there is loss in using it, and a much bigger mill has to be used to do the work.

In the plant at Marblehead, all winds below that corresponding to the 750 revolutions and over 1,500 are lost, and only at one speed, 1,200, is the dynamo doing its full duty. Nevertheless, by making the mill large, and using a large accumulator, it has been a success.

But, on the author's system, compressed air storage renders the regulation for varying speeds, minimum speeds and maximum speeds, totally unnecessary. If the air cylinders for storage, and the pressure be made great enough for a three or four days' supply, no accumulators are wanted at all. Storage can go on all the same, whether the dynamo is running or not.

A horizontal mill, built on the principle of Robinson's anemometer, as suggested by Prof. Blyth, and used by him in some of his experiments, would be, perhaps, the best type, as it does not race dangerously in high winds, and is ready to go at any time and with any wind.

ACCUMULATOR ELECTRIC LOCOMOTIVES.

MR. EPSTEIN'S criticism of the article on "More Electric Traction," in which we referred to Mr. Gibbings paper, requires an answer on some points. He claims to be able to prove his statements, and asserts that he has proved them; but the proofs are not to be found in his letter, nor in the three elaborate articles on the subject published in the ELECTRICAL REVIEW during January, 1894.

It may be since that date he has discovered an accumulator which realises the dreams of battery traction enthusiasts, and which will do all that he claims for it, and Mr. Gibbings may also have caught that accumulator; but as neither of them condescended to particularise the important improvements, and as no publication of them has been made, the proposals had to be discussed from the point of view of existing information. From that point of view, the arguments in our leading article against battery traction formed, at the subsequent discussion on the paper, the most telling points made by Mr. Manville, and also by Mr. Ferranti; in fact, the discussion proves that every objection made in the article coincides entirely with the opinion of experienced engineers.

In his January writings in this journal, Mr. Epstein gives a trolley car weight as 8 tons, and that of an accumulator car 10 tons; that is, 2 tons for accumulators. This is the weight given in our article. But in his letter he now claims three-quarters of a ton as the weight of accumulators. It is for him to explain the difference. He cannot blame us for unfairness in taking his own figures which were before us, while he keeps other figures to himself.

Then again, two and a half sets of batteries per car may work a system, but no responsible engineer, with the information now available, would recommend working to so close a margin of safety; three sets at least per car would, in practice, be insisted upon to guard against failures, and loss of time in running.

It is this very practice of inventors claiming too much for their cells which has been chiefly the cause of failure in battery traction.

We are all awaiting the advent of the cell which is to come up to Mr. Epstein's claims, and if he has found it, why not bring it out, and show us that it fulfils the requirements?

The discussion on the paper, and the previous records of battery traction, prove that we are not alone, nor, indeed, mistaken, in the opinions and facts set forth in the article to which Mr. Epstein takes exception.

We have reproduced in full the discussion on Mr. Gibbings's paper, so that the subject may be referred to without quoting in this place the corroborative statements made by others competent to pass opinions and give figures relative to battery traction. Finally, we must still hold that before any battery traction scheme can be accepted, great improvements in the cells have yet to be demonstrated.

BOARD OF TRADE INQUIRY REGARDING TRANSFORMER CHAMBERS.

The resumed hearing of the appeal of the County of London Company to the Board of Trade in reference to the objections of the London County Council to the proposal to construct transformer chambers under the streets, took place at 7, Whitehall Gardens, on Thursday, the 20th inst., Sir Courtenay Boyle presiding, and being accompanied by Major Cardew, electrical adviser to the Board of Trade, and Mr. F. G. S. Hopwood, C.M.G., of the Railway Department.

Mr. C. A. Cripps, Q.C., appeared for the County of London Electric Lighting Company, Mr. Germaine for the House-to-House Electric Lighting Company, Mr. Earl for the Wandsworth District Board of Works, and Mr. Bassett Hopkins for the London County Council.

Mr. Radford, surveyor for the parish of Putney, in the district of the Wandsworth Board of Works, put in plans showing sections of the streets in High Street, Putney, and elsewhere, where it was proposed to construct transformer chambers, and said that in his opinion there was not room for such chambers, especially having regard to the probable extension of the district and the widening of the roads.

Mr. Martin gave similar evidence with regard to the Streatham and Tooting districts.

Mr. Cripps, Q.C., then addressed the chairman on behalf of the electric lighting company. He said the contention that there was not room enough in the roadway was absurd, and was amply disproved by the fact that such chambers had been constructed underground in the City of London and in other places vastly more crowded than the districts spoken of by witnesses. The County Council had made repeated efforts to upset the understanding arrived at after much discussion by Sir George Trevelyan's committee, that undertakers of new works might use the streets, subject to the proper supervision, and upon the condition that they did not interfere with existing works. The view held by the County Council was, that the streets were the property of the public, and companies wishing to occupy them ought to pay them (the council) as representing the public for the use of them; but they had always failed to maintain this contention before Parliament. From the commencement the railways, gas mains, water mains, and so on, had occupied the streets without any payment, the principle being adopted that companies carrying out works for the public advantage should be encouraged rather than taxed. The County Council, moreover, was not the proper authority to interfere in this matter, the control of the mains of various kinds being resting with the vestries, the council having very limited rights in regard to the streets. He contended, therefore, first, that the council had greatly exaggerated the facts, and in the second place that they had no authority. This did not apply, of course, to the Wandsworth Board, who were the proper authorities to raise objections; but he met them by saying that they were mistaken in the view which they took. With regard to the point raised that transformer chambers were not "boxes," and that the provisional order did not contemplate the placing of such large structures under the streets, he said express permission was given by Section 12, subject to the approval of the local authority, to place such boxes down as were necessary for the purpose, among other things, of directing and controlling the supply of energy. Transformers were certainly required for that purpose, and therefore the chambers in which they were placed were boxes within the meaning of the section. The question for the Board of Trade, therefore, was as to the safety of the particular system to be used, and he would call leading experts who would state that the form of chamber proposed was perfectly free from danger.

Sir Frederick Bramwell, examined by Mr. Cripps, said a chamber of such small size as that proposed, constructed with a thickness of asphalte in the side walls between two pieces of brickwork, and a plate of lead at the bottom, was one which could not, under ordinary circumstances, receive gas by leakage. But if by some means, which he could not conceive, gas did get in, it could not possibly form an explosive mixture, as it would rise by reason of its levity, and escape through the top grating provided. There was no need for ventilation, understanding that word in the ordinary sense as implying a current of air. In 1867, when the question of subways was before Parliament, he made experiments at Southwark, and found that in the middle of a subway half a mile long, with the doors at the ends closed, and gratings at intervals of 100 feet, it was impossible to get more than from 2½ to 3 per cent. of gas in the atmosphere, even when an inch and a half gas pipe was turned on full. Matches were struck, and it was evident that an explosive mixture was not formed, the gas escaping freely at the gratings.

By Mr. Bassett Hopkins: The pipe ventilation provided in the company's plans was not in the least necessary, but would do no harm, and might satisfy people who had no practical knowledge of the matter. There was no necessity, upon grounds of safety, for the chambers to be watertight; that was merely a matter of convenience.

By Mr. Earl: The pan underneath the grating, with a drain pipe running off from it, provided in the plans, would prevent water from running into the chamber. Any gas given off by electrolysis would be very small indeed in quantity, and there was no danger to be anticipated from that cause. There would be no greater danger if the chambers were placed under the roadways instead of under the pavements, for they were constructed with quite sufficient strength to resist the effects of, say, a steam roller passing over them.

By the Chairman: There was the possibility of the earth above the transformer chamber becoming charged at a different potential, but there was no more danger to be anticipated than that a train might run off the line, or an ordinary boiler burst.

Prof. S. P. Thompson asserted his agreement with the evidence given by Sir Frederick Bramwell, and said it was almost impossible for gas to get into the chambers, whilst if it did get in it would inevitably escape through the grating.

By Mr. Earl: The chambers might be more readily ventilated if they were placed above ground on private property, but there were other considerations which made it important that they should be placed underground. The matter of expense was not the only reason why it was advisable not to have fewer transformers and those of larger size. It was more convenient to regulate the pressure over a small area than over a large one, and in case of a mishap a smaller district was inconvenienced by the stoppage of the light. The danger to the public would be less with small chambers than with large ones.

Dr. Fleming substantially agreed with the two former witnesses with regard to the safety of the transformer chambers. In reply to Mr. Bassett Hopkins, he said a certain amount of heat would be set up in the chambers, and that would have the effect of creating a current of air.

Mr. Lawson, engineer and manager of the County of London Company, put in the company's plans for the chambers proposed to be put in in the St. Luke's District, to which reference had been made by witnesses for the County Council, and said there would be no interference there with the existing pipes. The district surveyor was satisfied in that case; and in regard to the Wandsworth districts, there need be no difficulty, as the company were quite prepared to alter the positions of the transformer chambers wherever necessary. Companies had carried out precisely similar systems at Dover and Bournemouth, and no difficulties had arisen.

Mr. Bassett Hopkins, in replying, said that whilst the expert evidence showed a decided difference of opinion, it could not be denied that scientific men of great eminence had stated that the proposed system was unsatisfactory, and that it would be exceedingly difficult to keep the chambers efficiently ventilated, so that there would be no danger from explosions of gas. In any case, to make them and maintain them perfectly gas and water-tight would involve considerable expense, and he thought there would be great temptation to allow them to become insufficient in that respect. Further, it was an unreasonable construction to place upon the language of the order to say that the term "street boxes" covered, or contemplated, such structures as the present day transformer chambers. What was now proposed was an absolutely new departure, and one which Parliament had had no opportunity of discussing from the point of view of public policy and expediency. He did not agree with Mr. Cripps's view of the law in regard to the acquisition of vested interests in the streets; he considered that the law was against the idea of vested interests, and he was not sure that an injunction would not lie if the company attempted to assert the powers it claimed to possess. Still, he had such confidence in the Board of Trade that he should not advise the London County Council to test the question of law, but would be content to suggest that the decision of the whole matter be left in the hands of the Board of Trade. The sole right of ownership in the sub-soil was vested in the frontager, subject to certain powers reserved to the local authorities. This was the first time in history it was sought to establish the right to take possession of the subsoil in front of a man's house for private purposes, without asking his leave, without giving him an opportunity of objecting, and without offering him any compensation. He did not think the Board of Trade would take the responsibility of a decision upon a point such as that, but would hold that it was a matter for Parliamentary settlement. He further opposed the scheme because, if permitted, it would lead to a very large development, and would impose an enormously increased obligation in the way of supervision on the London County Council, and an enormous increase of cost to the ratepayers.

Mr. Earl, for the Wandsworth Board, opposed the scheme on the grounds of possible danger from explosions, and of interference with the rights of adjacent owners, and suggested as an alternative scheme that the chambers should either be constructed on private property, or erected above ground.

Sir Courtenay Boyle said it might be convenient if he stated what was the nature of the advice which he proposed to give to the Board of Trade. He could not be certain that that advice would be taken, and the ultimate decision of the Board of Trade would be made in writing. The Board of Trade did not contemplate that the term "street boxes" would be extended to include such structures as transformer chambers, but it did not follow that it would not now take the view that the term did in fact cover and include transformer chambers. The phrase "controlling energy" certainly suggested that view. He was in this difficulty, that if in the provisional order the words "street box" did not include and mean transformer chamber, then the company had no right there at all, and the Board of Trade was not the proper authority to settle the objections of the London County Council. If there was no power given by the provisional order to go under the streets for the purpose of constructing transformer chambers, then nothing that the Board of Trade could do could give that power. That being so, it behoved him to act as if the word "box" did include and mean "transformer chamber." Upon the question of public safety, his advice would be based upon the assumption that the case against the transformer chambers had not been made out. As long as a high tension system of supply was permitted at all, it must be allowed on the condition of the transformer chambers being placed under the streets in a manner which would satisfy the Board of Trade. The promoters had promised to listen to any representations that might be made by the advisers to the London County Council, or the Wandsworth, or any other local boards, as to possible improvements in the construction of the chambers; but, having regard to the scientific evidence given that day, he should certainly hold, and advise the Board of Trade, that transformer chambers might be made so reasonably free from risk, that it did not become the duty of the Board to veto their use. But then came the question as to within what limits transformer chambers

would be used. He saw no limit, nor did the engineer of the company, to the number which the company might ask for. Now, it appeared to him that an apparently unlimited number of transformer chambers, such as seemed possible, would be an extent of user of the public streets which the local authorities were justified in resisting, and which neither Parliament nor the Board of Trade contemplated. Therefore the action of the Board of Trade would be based on the view that the user of the streets for transformer chambers should be as far as possible curtailed, and that the chambers should be placed where they did not cause unnecessary interference. If there was any objection to the placing of a transformer in a particular place, the appeal clause came in, and each case would be considered as it arose. If the Board of Trade took his advice, it would not oppose *in toto* the use of transformer chambers under the streets, but would insist upon the adoption of proper safeguards.

Replying to Mr. Bassett Hopkins, the Chairman said he would consider the question of taking the opinion of counsel as to whether the word "box" should be taken to include "transformer chamber."

This terminated the proceedings.

LEGAL.

Reddaway and Others *v.* Banham and Others.

Before the Master of the Rolls, Lord Justice Lopes, and Lord Justice Rigby, on Tuesday last week, judgment was given in this case. This was an application by the defendants for judgment or a new trial in an action tried before Mr. Justice Collins and a special jury at Manchester. The action was for an injunction to restrain the defendants from continuing to use the word "camel" in such a manner as to deceive purchasers into the belief that they were purchasing goods (camel-hair belting) of the plaintiffs' manufacture, and from passing off their goods as and for goods of the plaintiffs' manufacture. It appeared that several years ago the Lancashire Belt Company made a camel-hair belting for machinery, and sold it as the Lancashire belting. Shortly afterwards (in 1879) the plaintiffs made a camel-hair belting for machinery, and called it Reddaway's camel-hair belting. At the trial the plaintiffs called evidence with the view of showing that in India a person buying camel-hair belting would expect to get Reddaway's camel-hair belting. The learned Judge granted the injunction claimed, and the defendants moved for judgment or a new trial. Mr. Bigham, Q.C., and Mr. M'Call, Q.C. (instructed by Messrs. W. C. Chew, Sons & Hilditch, of Manchester), for the defendants, contended that the defendants had a right to manufacture belting of camel-hair and to call it by its true name, and sell it as such, so long as they added nothing to the description likely to deceive purchasers. Mr. Gully, Q.C., and Mr. J. C. Graham (instructed by Mr. A. Macdonald Blair, of Manchester), for the plaintiffs, relied on the fact which had been found by the jury—that the words "camel-hair belting" had come to be understood by the public as indicating goods manufactured by the plaintiffs, and had ceased to be merely words of description.

The Master of the Rolls said that the action was for an injunction, and an injunction alone. The defendants, he held, had a right to imitate the plaintiffs belting, and if they were trying to beat them out of the market they had done nothing wrong. In calling the goods camel-hair belting they only told the truth. It was said that the defendants had a wrong intention—to pass off their goods as the plaintiffs'. Even assuming that to be so, the law took no notice of intention in a man's mind unless it was carried into effect by a wrongful act. Therefore, as the only default suggested was the using the name, intent was immaterial. In these circumstances the learned judge ought to have entered judgment for the defendants, and the appeal must therefore be allowed.

Lord Justice Lopes, in his judgment, said: Two questions arise. First, have the defendants correctly, in plain language, described the material of which their goods are made? Have they correctly described their goods? And, secondly, have they acted fraudulently, or misrepresented their goods as the goods of the plaintiffs? It was admitted by Mr. Gully that substantially they had correctly described their goods. To entitle the plaintiffs, therefore, to relief, they must make out either that the defendants, in addition to correctly describing their goods, had dressed them up or garnished them so as to make them resemble the plaintiffs' goods, or by words or conduct passed them off as the plaintiffs' goods, or endeavoured so to do. All I find is that they called their belting by the same name as the plaintiffs', and probably, as far as they could, imitated it; but this they are entitled to do. The plaintiffs, in my opinion, made out no case, and ought to have been nonsuited. The appeal must therefore be allowed.

Lord Justice Rigby delivered judgment to the same effect.

A BRIEF SUMMARY OF THE ELECTRICAL SECTORS OF PARIS.*

The Continental Edison Company.

The Drouot Station, 8, *Rue du Faubourg-Montmartre.*

Boilers.—Four Babcock & Wilcox boilers, three giving 2,600 kg. of steam per hour at a pressure of 6 kg. to the square centimetre, and one giving 3,200.

Four Belleville boilers, each supplying 1,500 kilogrammes of steam per hour at a pressure of 15 kg. to the square centimetre.

Engines.—Two Corliss horizontal engines of 300 H.P., one making 43 revolutions per minute, and the other 68. Two Weyher & Richemond compound engines of 100 H.P., at 160 revolutions a minute. Two Weyher & Richemond triple expansion vertical engines of 300 H.P., at 135 revolutions a minute.

Dynamos.—Ten Edison dynamos of 800 a., at 125 volts, with eight poles (100 kw.), at 350 revolutions per minute, two in series, five in parallel, driven by belts.

System of Distribution.—Three-wire distribution by feeders and loop circuits (two 120 volts); continuous currents.

Cables.—Cables of naked copper over porcelain insulators in concrete troughs, covered over with slates.

Accumulators.—Two batteries of 70 elements in series, supplied by the *Société pour le Travail Electrique des Métaux*, of a capacity of 3,000 ampère-hours.

Total Power.—100 kilowatts.

Remark.—The three stations (Drouot, Trudaine, and Palais-Royal) are connected in parallel for the evening supply; during the day one of them suffices for the consumption and supplies the energy required for charging the accumulators in the sub-station of St. Georges.

The Trudaine Station, 11, *Avenue Trudaine.*

Boilers.—Three Belleville boilers, each giving 3,000 kg. of steam per hour at a pressure of 12 kg. per square centimetre; one Belleville boiler, giving 3,800 kg. of steam per hour under the same conditions.

Engines.—Four triple expansion Weyher & Richemond vertical engines of 300 H.P. at 130 revolutions per minute.

Dynamos.—Eight Edison dynamos of 800 a., at 125 volts, with eight poles (100 kw.), at 130 revolutions per minute; two in series, four in parallel, worked directly by means of Raffard couplings.

System of Distribution.— Distribution by feeders and loop circuits, with three wires (two 120 volts); continuous currents.

Cables.—Cables of naked copper on porcelain insulators in concrete troughs, covered with slates.

Total Power.—800 kilowatts.

Palais Royal Station—Cour d'honneur.

Boilers.—Five Belleville boilers, each producing 2,500 kg. of steam per hour at a pressure of 12 kg. to the square centimetre.

Engines.—Six triple expansion Weyher & Richemond vertical engines of 150 H.P., at 160 revolutions per minute.

Dynamos.—Six Edison dynamos of 800 a., at 125 volts (100 kw.), at 350 revolutions per minute, driven by belts, two in series, three in parallel.

System of Distribution.—Three-wire distribution by feeders (two 120 volts); continuous currents.

Cables.—Insulated cables laid in pipes.

Accumulators.—Auxiliary batteries at the Théâtre Français and at the Théâtre du Palais Royal.

Total Power.—600 kilowatts.

Remarks.—A special installation consisting of two Zipernowski alternators, of 50 a. and 2,000 volts (100 kw.), at 260 revolutions per minute, driven by two vertical engines of 150 H.P., supplies the Palais de l'Elysée on *fête* days, by means of armoured cables laid in pipes. The alternators are coupled in parallel.

The Saint-George's Sub-station, 38, *Rue Saint-George's.*

No boilers.

Engines.—An Edison motor of 250 a., at 120 volts (55 kw.), branched on the system at 700 revolutions per minute.

Dynamos.—One Edison dynamo of 350 a., at 90 volts, worked directly by the motor by means of a Raffard coupling.

System of Distribution.—The object of this sub-station is to keep constant the difference of potential at certain points far away from the centre of consumption.

Accumulators.—Two batteries of 64 Tudor elements in series of 2,800 ampère-hours.

Total Power.—Forty kilowatts.

* *L'Industrie Electrique.*

Remarks.—The accumulators are charged by the system in quantities varying in order to attain to the difference of potential of the distribution; the surplus ones are charged by the continuous current transformer. A distribution board enables the charging or discharging to be started.

JOINT-STOCK COMPANY FOR THE ELECTRIC LIGHTING OF THE PLACE CLICHY.

Central Station of the Sector, 53, Rue des Dames.

Boilers.—Eight Nœyer boilers, each supplying 2,500 kg. of steam per hour at a pressure of 8 kg. to the square centimetre.

Engines.—Three horizontal Corliss engines, non-condensing, 500 H.P. at 64 revolutions per minute.

Two compound vertical engines of 500 H.P. at 64 revolutions per minute.

Three two-cylinder horizontal Armington engines, of 150 H.P. at 240 revolutions per minute.

Dynamos.—Five 8-pole dynamos with outer collector, of 500 volts, 700 a., or 350 kw., driven directly by the horizontal Corliss engines and the compound vertical engines.

Six Siemens 2-pole shunt dynamos of 200 a. and 250 volts, or 50 kw., at 380 revolutions per minute, driven by belts.

System of Distribution.—Distribution by feeders with 5 wires at 440 volts (four 110 volts), with compensating systems of four dynamos placed in regulating stations and also accumulators.

Cables.—Insulated, lead-covered, armoured cables (Siemens system) laid directly in the earth in a layer of fine sand.

Distribution and derivation boxes hermetically closed.

Accumulators.—Two batteries of 250 elements, supplied by the *Société pour le Travail Electrique des Métaux*, 500 volts, 2,000 ampère-hours, with an output of 250 ampères.

One battery of 270 Tudor elements, 500 volts, 3,000 ampère-hours, with an output of 300 ampères.

Total Power.—2,050 kilowatts (dynamos), 400 kilowatts (accumulators).

Remarks.—The only central station with regulating substations.

The electrical canalisation is in very good condition; insulation very high.

The Aron meter used.

THE HALLES CENTRALES MUNICIPAL STATION.

Central Station, Rue Vauvilliers, Halles Centrales.

Boilers.—Six Belleville boilers, furnishing 1,500 kg. of steam per hour at a pressure of 15 kg. to the square centimetre.

Engines.—Three Weyher & Richemond triple-expansion engines, of 150 H.P. at 160 revolutions per minute.

Three Leconteux & Garnier engines of the Corliss type, with tandem condenser—170 H.P. at 180 revolutions per minute.

Dynamos.—Six 2-pole Edison dynamos, 330 a., 120 volts, or 40 kilowatts, at 600 revolutions per minute, driven by belts.

Three alternating current Ferranti dynamos of 2,400 volts, 46 a., or 110 kilowatts at 530 revolutions per minute, driven by ropes.

Four Desroziers dynamos of 250 a., 120 to 170 volts, or at the maximum 42·5 kilowatts, for charging the accumulators.

System of Distribution.—Feeders with 3 wires at two 110 volts. Feeders at 2,400 volts. Separate circuits.

Cables.—Insulated cables supported on insulators in concrete troughs.

Siemens's lead-covered armoured cables.

Insulated cables in mouldings of sulphated wood laid in concrete troughs.

Transformers and Accumulators.—Two batteries of 67 accumulators supplied by the *Société pour le Travail Electrique des Métaux*, of 200 ampère-hours.

Total Power.—240 kilowatts (dynamos), 50 kilowatts (accumulators), 330 kilowatts (alternators).

Remarks.—This station effects the lighting of the Halles Centrales, and distributes electrical energy to a few consumers.

During the day the four Desroziers dynamos can be worked by two Leconteux & Garnier steam engines solely for charging the accumulators.

THE ELECTRIC LIGHTING AND POWER COMPANY.

The Saint-Ouen Station, Quai de Seine.

Boilers.—Eight Roser tubular boilers, each supplying 2,000 kg. of steam per hour at a pressure of 12 kilogrammes to the square centimetre.

Engines.—Four groups of 2 horizontal Leconteux and Garnier engines, of the Corliss type, coupled two-by-two on the same fly-wheel, 150 H.P. each, at 65 revolutions per minute. Intermediate transmission for driving the dynamos.

Dynamos.—Eight double-ring Marcel Deprez continuous-current dynamos of 2,500 volts and 30 a., at 600 revolutions per minute, or 75 kw.

Four Hillairet dynamos of 250 a. and 120 volts, or 30 kw., for excitation and other purposes.

System of Distribution.—High-tension distribution with continuous current transformers, four feeders; one for the Boulevard Barbès, one for the Gare du Nord, Paris, one for Asnières, and one for Saint Denis.

Cables.—Outside Paris, overhead wires on posts with insulators along the Northern Railway lines as far as the fortifications.

In Paris, insulated cables laid in troughs, with insulators.

Accumulators.—Low power battery for regulations.

Total Power.—600 kilowatts.

Remarks.—The low-tension electrical energy is distributed about the neighbourhood to the Northern Railway works, to the *Société pour le Travail des Métaux*, to the Sleeping-Car Company, to the windlasses, &c.

The Bondy Station, 70, Rue de Bondy.

Boilers.—Four Belleville boilers, each giving 1,500 kg. of steam per hour, at a pressure of 15 kg. to the square centimetre.

Engines.—Four Weyher & Richemond triple-expansion vertical engines of 150 H.P. at 160 revolutions per minute, driving the dynamos by belts.

Dynamos.—Four Desroziers dynamos, 750 a., 130 volts, or 97·5 kilowatts, at 260 revolutions per minute.

System of Distribution.—Feeders with 2 wires.

Cables.—Cables of naked copper laid on porcelain insulators in concrete troughs.

Accumulators.—Battery of 67 elements, supplied by the *Société pour le Travail Électrique des Métaux*, of a capacity of 11 kilo-ampère-hours. Normal output 700 ampères.

Total Power.—400 kilowatts (dynamos), 91 kilowatts (accumulators).

The Filles-Dieu Station, 13, Rue des Filles-Dieu.

Boilers.—Four boilers similar to those used at the Bondy station.

Engines.—Four engines, similar to those used at the Bondy station, driving the dynamos direct by Raffard couplings.

Dynamos.—Four Desroziers dynamos similar to those used at the Bondy station, at 160 revolutions per minute.

System of Distribution.—Feeders with 2 wires.

Cables.—Cables of naked copper, laid on porcelain insulators in concrete troughs.

Accumulators.—Battery similar to the one used at the Bondy station.

Total Power.—Four hundred kilowatts (dynamos), 91 kilowatts (accumulators).

The Gare du Nord Station, 183, Faubourg Saint Denis.

Boilers.—Two boilers similar to those used at the Bondy station.

Engines.—Two Weyher & Richemond triple expansion vertical engines of 150 H.P. at 160 revolutions per minute, driving the dynamos directly.

Three Marcel Deprez double ring continuous current electro-motors, 2,400 volts, 30 ampères, at 600 revolutions per minute.

Dynamos.—Two Desroziers dynamos, similar to those at the Bondy station, at 160 revolutions per minute.

Six Edison 2-pole dynamos, 175 volts, 250 a., or 44 kilowatts, worked directly by the motors by means of Raffard couplings, two on each receiver.

System of Distribution.—Feeders with 2 wires.

Cables.—Cables of naked copper on porcelain insulators in concrete troughs.

Accumulators.—Battery of 67 elements, similar to the one

used at the Bondy station of 9 kilo-ampère-hours. Normal output 500 ampères.

Total Power.—One hundred and ninty-five kilowatts (dynamos), 70 kilowatts (accumulators), 260 kilowatts (dynamos).

Remarks.—The Bondy, Filles-Dieu, Gare du Nord, Barbés, and la Villette stations are all connected in parallel with the system of distribution.

The Barbès Station, 11, *Boulevard Barbès.*

Boilers.—None.

Engines.—Four electromotors, similar to those at the Gare du Nord Station, each working directly two dynamos.

Dynamos.—Four Edison dynamos similar to those at the Gare du Nord, four Breguet 2-pole dynamos, 150 volts, 300 a., or 45 kilowatts.

System of Distribution.—Feeders with two wires.

Cables.—Cables of naked copper on porcelain insulators in concrete troughs.

Accumulators.—Battery of 67 elements similar to that used at the Bondy Station of 3·3 kilo-ampère-hours. Normal output 500 ampères.

Total Power.—356 kilowatts (dynamos), 65 (accumulators).

La Villette Station, 1, *Quai de la Loire.*

Boilers.—Two Belleville boilers, each giving 1,500 kg. of steam per hour at a pressure of 15 kg. to the square centimetre.

Engines.—Two Weyher & Richemond vertical engines of 150 H.P. at 160 revolutions per minute, driving the dynamos directly by means of Raffard couplings.

Dynamos.—Two Desroziers dynamos, 750 a., 130 volts, or 97·5 kilowatts at 160 revolutions per minute.

System of Distribution.—Feeders with two wires.

Cables.—Cables of naked copper on porcelain insulators in concrete troughs.

Accumulators.—Battery of 67 elements similar to that used at the Bondy Station of 6 kilo-ampère-hours. Normal output 700 ampères.

Total Power.—200 kilowatts (dynamos), 86 kilowatts (accumulators).

THE CHAMPS-ELYSEES SECTOR COMPANY.

Central Station, Quai Michelet, at Levallois-Perret on the Banks of the Seine.

Boilers.—Five Galloway boilers, each producing 3,000 kg. of steam per hour, with a Green economiser at a pressure of 6 kg. to the square centimetre.

Engines.—Two Farcot horizontal condensing engines of 600 H.P. at 60 revolutions per minute.

Two similar horizontal engines of 300 H.P. at 60 revolutions per minute.

Dynamos.—Three Hillairet-Huguet alternators of 133 a. and 3,000 volts, or 400 kw., with a frequency of 40 periods per second, driven directly. Revolving field-magnets.

Three Hillairet-Huguet exciters with eight poles, 100 a., 160 volts, or 25 kw.

System of Distribution.—Alternating current feeders at 3,000 volts.

Cables.—Berthoud-Borel lead-covered armoured concentric cables, laid directly in the ground and supplied by the Cail Company, Paris.

Transformers.—Transformers installed on the premises of consumers in special chambers with derivation circuit-breakers.

Total Power.—1,200 kilowatts.

Remarks.—The present station is established on the banks of the Seine, with all the space required and all the necessary appliances. The power can easily be increased.

THE LEFT BANK SECTOR COMPANY.

Central Station, 4, *Place Sainte-Geneviève.*

Boilers.—Two Collet boilers, each giving 1,000 kg. of steam per hour at a pressure of 6 kg. to the square centimetre.

Engines.—Two steam engines of 60 H.P.

Dynamos.—Three Oerlikon dynamos of 300 a. and 110 volts or 33 kilowatts.

System of Distribution.—Feeders at 110 volts.

Cables.—Insulated lead-covered cables laid in the ground.

Accumulators.—Two batteries of 60 accumulators of 800 ampère-hours.

Total Power.—100 kilowatts.

Remarks.—In course of installation.

The sector is to be supplied from a central alternating current station to be established at Ivry. The present station temporarily effects the distribution through a few of the neighbouring districts.

THE PARIS COMPRESSED AIR COMPANY.

The distribution throughout the sector is at present effected by continuous currents :—

I. By a high tension system.

II. By a low tension system.

I. The high tension system comprises :—

a. Central stations.

1. Richard-Lenoir.

2. Saint-Fargeau.

Coupled in series, 3,000 *volts.*

β. Sub-stations.

1. Saint-Roch.

Rotatory transformers with 5-wire distribution on a secondary system.

2. 25 sub-stations in Paris.

Accumulators with secondary systems and rotatory transformers.

II. The low tension system comprises :—

a. The Bourse du Commerce station.

Distribution at 110 volts, special system at 1,500 volts for arcs connected in series.

β. The Rue des Jeûneurs station.

Distribution at 110 *volts.*

γ. The Retiro station.

Distribution at 110 volts, special system at 2,500 volts for arcs connected in series.

The present arrangements are undergoing a complete transformation.

High Tension System.

Richard-Lenoir Central Station, 35, *Boulevard Richard-Lenoir* (*Primary*).

Boilers.—Four Babcock and Wilcox boilers, each producing 3,000 kg. of steam per hour at a pressure of 12 kg. to the square centimetre; two Collet boilers, each producing 2,500 kg. of steam per hour at a pressure of 10 kg. to the square centimetre.

Economisers and purifiers.

Engines.—Four Weyher & Richemond triple expansion vertical steam engines of 300 H.P. at 135 revolutions per minute; one Duvergier horizontal condensing steam engine of 500 H.P. at 70 revolutions per minute; one Duvergier horizontal steam engine of 120 H.P. at 70 revolutions per minute.

Dynamos.—Eight Desroziers dynamos of 400 volts, 250 ampères or 100 kw., with eight poles, at 135 revolutions per minute, driven directly by means of Raffard couplings; 2 Desroziers dynamos, similar to the last, worked by belts; 10 exciting dynamos driven by belts; 5 Thury dynamos of 100 a., 100 volts or 10 kw., at 800 revolutions per minute; and 5 Sautter dynamos of the same power at the same angular speed.

System of Distribution.—Distribution by groups of accumulators or transformers placed at various points in the sector (sub-stations) and charged in series.

For charging, the two stations Richard-Lenoir and Saint Fargeau, are coupled in series. The charge is 250 a., and the difference of potential varies up to 3,000 volts.

Cables.—Insulated cables placed in casings of paraffined wood, these casings being laid in cast-iron troughs in the ground.

Total Power.—1,000 kilowatts (dynamos).

The Saint-Fargeau Central Station, 8 *and* 10, *Rue Saint-Fargeau* (*Primary*).

Boilers.—Ten Cornwaldt boilers, each producing 3,000 kg. of steam per hour at a pressure of 8 kg. to the square centimetre.

Five Paxman boilers, each producing 2,500 kg. of steam per hour at a pressure of 8 kg. to the square centimetre.

Engines.—One horizontal two-cylinder Cockeril steam engine, of 500 H.P. at 42 revolutions per minute.

One similar steam engine.

Three similar steam engines.

Two Willans engines of 28 H.P. at 550 revolutions per minute.

Dynamos.—Two dynamos supplied by the *Société Alsacienne* (Belfort), of 250 a., 500 volts, or 125 kw. at 180 revolutions per minute.

One dynamo similar to the above, and one Edison dynamo of 250 a., 400 volts, or 100 kw., at 160 revolutions per minute.

Three Thury dynamos of 250 a. and 1,000 volts, or 250 kw., at 220 revolutions per minute.

Two Thury dynamos of 40 a. and 200 volts, or 8 kw. at 550 revolutions per minute (for excitation).

Cables.—Insulated cables placed in casings of paraffined wood, these casings being laid in cast-iron troughs in the ground.

Total Power.—1,100 kilowatts (dynamos).

Saint-Roch Sub-station, 26, *Rue Saint-Roch (Secondary).*

Engines.—Twelve Thury electro-motors of 80 kw. at 400 revolutions per minute, connected four in series on the system, three in parallel.

Four Thury electro-motors of 40 kw. at 400 revolutions per minute.

Dynamos.—Twelve Thury dynamos of 600 a. and 120 volts, or 72 kw., worked directly by the electro-motors by means of Raffard couplings.

Four Thury dynamos of 300 a. and 120 volts, or 36 kw., worked as described above.

System of Distribution.—Secondary system of distribution at 440 volts by 5 wires (four 110 volts).

Cables.— Lead-covered armoured Siemens cables, laid directly in the earth.

Transformers and Accumulators.—Twelve Thury continuous current transformers of 80 kw., and 4 of 40 kw.

Two batteries of 260 Tudor elements of 2,000 ampère-hours branched on 440 volts.

Eight Tudor batteries of the same capacity, four in series, two in parallel of 67 elements each. The four batteries of the intermediate wires have 75 elements for reductions.

Total Power.—1,000 kw. (transformers), 200 (accumulators).

Sub-Stations in Paris (25 in number).

Engines.—In some sub-stations Thury electro-motors.

Dynamos.—In some sub-stations Thury dynamos (continuous current transformers).

System of Distribution.—Secondary systems of distribution at 110 volts with two wires, some connected in parallel.

Cables.—Insulated cables placed in casings of paraffined wood, the casings being laid in cast-iron troughs in the ground.

Transformers and Accumulators.—Batteries of accumulators, varying in number, scattered over the 25 sub-stations. The batteries are coupled in parallel as required. Some sub-stations are furnished with continuous current Thury transformers.

Low-tension System.

α. Bourse du Commerce Station, under the Bourse.

Engines.—Two Farcot compressed air engines of 75 H.P., coupled on the same axle, at 70 revolutions per minute.

One Farcot compressed air engine of 160 H.P., at 52 revolutions per minute.

One Daix horizontal compressed air engine of 150 H.P. at 160 revolutions per minute.

Dynamos.—One Desroziers dynamo of 800 a. and 125 volts, or 100 kw., at 160 revolutions per minute.

One dynamo similar to the above.

One Desroziers dynamo of 250 a. and 400 volts, at 160 revolutions per minute.

One Thomson-Houston dynamo of 7 a., 1,500 volts, or 10·5 kw.

System of Distribution.—Distribution at 110 volts.

Distribution at 1,500 volts for arcs in series.

Cables.—Insulated cables placed in casings of paraffined wood, these casings being laid in cast-iron troughs in the ground.

Accumulators.—Two batteries of 67 accumulators of 2,100 ampère-hours, supplied by the *Société pour le Travail Electrique des Métaux.*

Total Power.—310 kilowatts (dynamos), 30 kilowatts (accumulators).

Remarks.—The stations of the Bourse du Commerce and the Rue des Jeûneurs are to be converted into transforming stations like the Saint-Roch station, with rotatory transformers and systems of secondary distribution with five wires. All the other sub-stations will disappear, and also the Retiro station.

β. The Rue des Jeûneurs Station, 14, *Rue des Jeûneurs.*

Engines.—Two horizonal compressed air engines of 75 H.P., at 90 revolutions per minute.

Two Paxman compressed air engines of 50 H.P. at 125 revolutions per minute.

Dynamos.—One Thury dynamo of 400 a. and 125 volts, or 50 kw. at 600 revolutions per minute.

One Thury dynamo of the same power at 400 revolutions per minute. One Thury dynamo of 250 a. and 125 volts, or 31 kw. at 600 revolutions per minute.

One Edison dynamo of 240 a. and 125 volts, or 30 kw. at 900 revolutions per minute.

System of Distribution—Distribution at 110 volts.

Cables.—Armoured cables.

Total Power.—160 kilowatts (dynamos).

The Retiro Station, 35, *Rue Boissy d'Anglas.*

Engines.—Three horizontal compressed air engines of 50 H.P. at 90 revolutions per minute.

Three Paxman compressed air engines of 50 H.P. at 52 revolutions per minute.

Dynamos.—Three Rechniewski dynamos of 400 a. and 125 volts, or 50 kw. at 300 revolutions per minute.

Three Thomson-Houston dynamos of 2,500 volts and 10 a., at 820 revolutions per minute.

System of Distribution.—Distribution at 110 volts.

Distribution in series at 2,500 volts for arc lamps.

Cables.—Insulated cables placed in casings of paraffined wood in cast-iron troughs.

Insulated lead-covered cables in cast-iron pipes.

Total Power.—225 kilowatts (dynamos).

Remark.—The Retiro Station was established for feeding the arc lamps of the great Boulevards (Madeleine) and the Rue Royale, and also for supplying some important consumers in the neighbourhood.

RESEARCHES INTO THE ELECTROMOTIVE PHENOMENA OF PHYSIOLOGY.

"It is time to protest vigorously," says Mr. St. George Mivart, "against the statement that the several departments of science should each be kept 'carefully apart' from the highest department of science—from that which alone gives validity to every other." Such a statement is really as absurd as it would be to say that arithmetic should be kept carefully apart from the philosophic conception of *number* and geometry from that of *extension*. We entirely agree with this protest. The impossibility of teaching physical science, for example, in terms of mere phenomena, has seldom been more strikingly illustrated than in Prof. Pearson's recent work on physics—an attempt to effect the impossible. Our present day leaders in science have still much to learn as regards method before they will realise that progress which, presumably, is their great aim and object. To the physiologists, amongst others, we would also recommend this view, for it is becoming almost daily more apparent that no true conceptions of the life processes will be attained, and no real advance effected until they recognise that electricity and chemistry are inseparably bound up with what they are pleased to designate the science of life.

Mr. E. Waymouth Reid is a physiologist who has cut himself adrift from the antiquated methods which continue to fetter the energies of other investigators in his special field of research. And why not? In so many instances of

physiological action has it been demonstrated that there is a development of electromotive force that one almost expects to find an electrical expression of any essential vital phenomenon that may come under consideration. In muscle and nerve the story has been studied now for time enough, and the mass of our knowledge of the processes underlying the development of electricity in animal tissues, culled from these, forms the real base upon which the generally accepted theory of the subject mainly rests, and the standard to which the points of the most recent discoveries are frequently referred. What knowledge we have of the electrical events taking place in secreting cells is, however, of fairly recent date, and although the accumulation of facts is considerable, their interpretation is as yet a matter of great difficulty.

In a recent number of *Science Progress* there is an admirable paper by Mr. Reid, in which he reviews our knowledge of the electromotive phenomena of glands, and criticises the theories which have been put forward by various experimentalists in order to explain them. Whilst it is impossible with the limited space at our command to follow the writer through the history of observed facts which he gives us, we may note the leading principles which have been discovered and deal briefly with the two most reasonable theories which have hitherto been put forward to account for the experimental data.

Emil du Bois-Reymond in 1851 discovered that the skin of the frog was itself a source of electromotive force which was altogether of too high a magnitude to be attributable to mere differences in chemical reaction between the parts to which the electrodes were applied. Finding that the removal of the layers which contained the glands abolished the current, he concluded that the glands of the skin were a source of electromotive force with ingoing current.* Rosenthal confirmed the truth of this observation, and further demonstrated that a similar current could be derived from both the acid stomach and the alkaline gut of frog and rabbit. Such currents, probably of glandular origin, were known as "currents of rest." It was now necessary to obtain evidence of "currents of action" as the result of excitation of the nerves of the skin glands. Valentin and Roeber, especially the latter, soon supplied this evidence. The latter observed an outgoing "current of action" (that is a negative variation of the current of rest) to be the rule, though the matter was complicated by the occasional appearance of an ingoing current.

The matter next became the subject of a masterly research by Engelmann, who came to the conclusion that the current of the resting skin derived its E.M.F. from the fibres of the contractile sheath of the glands, and this E.M.F. he considered as the "Triebkraft" for the passage of fluid across the living cells in an act of secretion. It must here be observed that Hermann, who studied this subject, arrived at a conclusion quite opposed to finding of Engelmann, since he got as a normal direction of the "current of action" the ingoing direction. Bach and Oehler continued Hermann's work, using drugs for stimulating the glands, and their results led Hermann to formulate a distinct theory of the electromotive action of the skin, which defined it as quite epidermic in origin. Bayliss and Bradford, who subsequently investigated it, concluded that the "rest current" of the frog's skin is partly epidermic and partly glandular. Time of year is also considered by these observers as an important factor as regards the nature of the action current, outgoing currents predominating during and just before the breeding season, while, during the rest of the year an ingoing phase is the rule.

Similar observations to those above recorded have been made by Luchsinger and others, the objects of investigation being the sweat glands of the cat's foot; the lingual glands of the frog; the glands on the snouts of the pig, goat, cat and dog, and the salivary glands of the cat and dog. The last named were investigated by Bayliss and Bradford, and the net conclusions which they arrived at were that the outgoing secretion current, so marked in free flows of saliva, is electro-capillary in origin, while the ingoing secretion current is produced during the metabolic cell events necessitated in the elaboration of the organic constituents of the saliva. This is one of the most important of the explanations yet offered.

There appeared last year a paper by Biedermann, in which the electrical phenomena in several cases of mucous glands are detailed, and the results are apparently so consonant, that the work not only carries considerable weight, but the theory of actions must certainly rank as one of the best put forward, especially as it tends in the case of the frog's skin to reconcile some of the opposing results obtained by Roeber and Engelmann on the one hand and Hermann on the other. Briefly, the theory is as follows:—Adopting Hering's extension of the alteration theory, viz., that alterations in metabolism, rather than of chemical compostion in protoplasmic continuity, lie at the root of vital electrical changes, Biedermann points out that in the gland cell we have a structure pre-eminently liable to variations from the balance between constructive and destructive events. That part of the protoplasm of the cell engaged in the elaboration of the secretory products, though ordinarily the seat of an excess of katabolic over anabolic activity, must at the same time be in a highly unstable state, and liable under certain conditions to an overthrow of balance to the opposite side. The electrical sign of a part in which katabolism is in excess of anabolism is negative as contrasted with that of a balanced part; more negative still to a part where anabolism is in excess of katabolism, and, of course, *vice versâ* as regards positivity. Thus, it is supposed, differences of potential may be originated in the cell as the result of its vital processes, and the cell current will depend, as regards its direction, upon the predominance of either one or the other processes, and the relation of the resultant condition to that of the rest of the protoplasm. The act of production of the secretion by the cell is one in which katabolic action is in the ascendant, so that that part of the cell in which the secretion is occurring should be negative to the deeper parts with a resultant ingoing current when put in circuit; and upon this hypothesis Biedermann explains the ingoing "current of rest," as being the electrical expression of a continuous and predominantly katabolic activity. As regards the ultimate nature of these processes, secretions of water is suggested as the katabolic process, since in cases in which a mucous surface is found bedewed with secretion the electromotive force of its "current of rest" is always higher than when it is dry, and as the anabolic process—the building up of complex organic paraplasm.

Mr. Reid then details a number of experiments which give results confirmatory of Biedermann's theory, Bohlen's experiments with mammals are also cited on the same side.

A word must now be said as regards what is probably the highest development of electromotive force in glandular tissue. Fritsch has maintained that the electrical organ of the fish *Malapterurus* is constructed of a mass of glandular cells, known as "club cells," and derived originally from the overlying skin, in which in the adult many are to be found. The theory is extremely probable, but, unfortunately, as yet lacks embryological basis. These "club cells" are present in the epidermis in other fish along with "goblet cells," and it has recently been pointed out in the case of the skin of the common eel, that while the "action current" of a part rich in "goblet cells," and clear of "club cells," such as the lip, conforms in its conditional modifications to that described by Biedermann for ordinary mucous surfaces, the current from the body skin, which is richly set with "club cells," but sparsely so with "goblets," does not agree with Biedermann's story, but gives an ingoing "action current" to a stimulus that elicits an outgoing current in the mucous lip. The discharge of *Malapterurus* is peculiar in that the nervous sides of the electrical discs become positive to the non-nervous, and the observation as regards the direction of the action current of the club cells of the eel just mentioned, gives physiological backing to Fritsch's idea and would serve to explain the anomalous direction of the "shock."

A criticism of the various theories which have been advanced is next indulged in by Mr. Reid, and his conclusion is that only two of these theories are worthy of being taken seriously, namely that of Biedermann and that of Bayliss and Bradford. The respective points in these theories are set out and compared, with the result, we think, of showing that personally Mr. Reid is unable, in the present state of our knowledge, to choose between them, although there is evidence of a leaning in favour of Biedermann's hypothesis.

* *Ingoing* and *outgoing* applied to gland currents have the following significance: ingoing current means a current reversing *in the gland* from neck to base, *i.e.*, neck galvanometrically negative to base, outgoing has, of course, the opposite meaning. Less confusion arises from the use of these terms than from that of the terms − and +.)

For ourselves we opine there is much that is attractive and reasonable in each theory, and we look forward to a time, in the immediate future, when a rational explanation of these electromotive phenomena shall be set forth, which will probably be evolved when the two rival theories have been subjected to further tests by means of new experimental data.

One thing is quite clear: the review which Mr. Reid gives of the researches into the electrical aspect of physiology and the copious bibliography which he appends to his article shows that this interesting subject is being rescued from the quacks and charlatans who have used it for so many years as their happy hunting ground. Earnest scientists with the qualifications of genius for their work are now exploring those hidden life processes which, till now, have only been a sort of shibboleth to conjure with in certain quarters. In this, as in so many other things, science will triumph over imposture, though no set effort be made; and the end seems to be not far distant.

CORRESPONDENCE.

Theory and Practice in Electrical Engineering.

Those of your correspondents whose letters have lately appeared in the Review, seem only to have considered the merits of the continuous and alternating current, as regards first cost of plant, and they have said nothing about the question from the consumers' point of view.

The supply of electricity, as far as London is concerned, is fairly well divided between the two systems, and these have now been in use sufficiently long to enable one to form an impartial comparison as to their suitability from the consumers' point of view.

The current furnished by the three large direct supply companies has been uniformly steady and regular from the commencement, and what is of more importance, there does not appear to have been a breakdown on any of their important sections; the current can be used for any purpose for which electricity is required.

On the other hand, the magnificent "earths" thrown in with their supply by the three-wire companies is a weak point, and must before long lead to trouble to all concerned.

As regards the alternating concerns, the London Company has certainly managed during the past 12 months to get along without any serious breakdown, but still the current provided is not by any means free from variations and characteristic disturbances.

The regulation of the West End circuits of the Metropolitan Company cannot be said to be satisfactory, or, indeed, anything like as good as that of the direct supply companies, and the frequent variations of pressure and "blinks"—caused, no doubt, by the system of regulation in use—have been very evident to those supplied by that company, while as to extinctions, only in your last issue there was a notice of a failure for a quarter of an hour of one of the most important sections in Oxford Street.

The recent breakdown of the alternating supply in the City will be fresh in the minds of your readers.

On the whole, therefore, there seems to be no doubt that those who draw their electricity from the direct current mains obtain a much more regular and reliable supply than those who trust to the alternating companies. The latter do not by any means furnish such a regular and steady light as that provided by the continuous companies, and, in view of past experience, no one can honestly say that the alternating current is reliable, or the direct current the reverse.

In comparing the two, other objections must occur to the minds of your readers. The difference in E.M.F. between light load and full load of converters, is one; the rentals, again, demanded by the alternating companies for their primary apparatus are an important addition to the yearly bill for electricity, while the effect of the alternating current on telephones and other instruments of that nature, is another objection.

It is also a nuisance that two of the alternating companies do not appear to be able to join on additional lights without cutting off the current from the high pressure main supplying that particular section.

And then comes the question of motors; to the direct current motor, properly made, there is no objection, and numbers are in use in London. The writer is unaware of any alternating motors in use, commercially, at the present moment, and when these motors come into use, it will be interesting to know how it will be possible to vary their speed, which is naturally high, and how it will be proposed to prevent the motors from dropping out of phase every time the generating machines at the station are changed over, as must happen from time to time.

The existing meters, also, used by the majority of alternating companies, will not register correctly the power absorbed by motors, arc lamps, choking coils, and other apparatus of a like nature.

G.

In his letter published in your issue for the 7th inst., Mr. Rankin Kennedy assumes that at Scarborough we have only feeders working at high pressure, and that our distribution is all done at low pressure. No doubt this assumption is very convenient for his contention; but, unfortunately for his argument, it is altogether incorrect.

In the first place, as a matter of fact, we have no feeders in the proper sense of the word at all, as we tap off for isolated consumers at points distributed along the full length of our high tension mains; and, secondly, our low tension distributing mains are confined to only two or three streets in a small portion of the town. Indeed, though 107 out of the 186 separate consumers that we are now supplying are connected to these low pressure distributing mains, many of these are very small consumers, and the greater bulk of the lamps that we supply—6,310 out of a total of 11,038 equivalent 8 C.P. lamps—are fed from isolated transformers located on the consumer's own premises, and connected, in some cases, to the same high tension mains that feed the low pressure system.

To give any really clear idea of how impossible it would have been at anything approaching the actual capital cost of our existing system, as given below, to have supplied our present consumers from any low tension distributing network fed by feeders either with or without transformers, would necessitate giving a large scale map of the town showing the positions of our various consumers in relation both to one another and to the generating station. Such a course is obviously out of the question, but some idea of what this would mean may be gathered from the fact that on any such system we should still require nearly the whole of our existing high tension mains—10,173 yards in length—for use as feeders, and, in addition, practically another 10,173 yards of low tension distributing mains. This, in itself, would mean about doubling the expense, but with low tension there would be a further large increase in cost, owing to the feeders having to be of sufficient section to transmit the required amount of energy at, say, 200 volts, instead of at 2,000.

As against this great increase in capital cost, there would no doubt be some saving in the cost of the transformers, but the amount of such saving would be a mere fraction of the total extra expense. No doubt, where it can be carried out at reasonable cost, the low pressure network, fed either by transformers or by continuous current feeders, is the right system to adopt; but, under the conditions obtaining at Scarborough, the cost of such a system would have been simply prohibitive.

The above will make it clear that no such comparison as Mr. Rankin Kennedy suggests between the system actually employed at Scarborough, and a low tension network fed by low tension feeders, is possible. It may, however, all the same, be interesting if I give the actual cost of the system as it exists. The figures are as follows:—

Low Pressure Distributing Mains.

2,519 yards of pipes, including boxes and laying...	£850
Cables	1,006
	£1,856

High Pressure Distributing and Feeding Mains.

10,173 yards of pipes, including boxes and laying	£3,650
Cables	2,134
	£5,784
Transformers and earthing devices	£1,867

It should be mentioned that throughout the pipes are of a size that will admit of additional cables being pulled in as required. The total for high and low pressure mains, transformers, boxes, and earthing devices, thus comes to £9,507. We have now 11,038 equivalent 8-C.P. lamps connected, so that the total for mains, transformers, &c., works out at only 17s. 2d. per lamp. Having regard to the considerable distances we cover, does Mr. Rankin Kennedy venture to suggest that anything like this low figure could be attained with low tension? If so, will he give some figures showing how he would propose to effect it?

So far I have dealt only with the more important question of mains, but Mr. Rankin Kennedy also assumes that in either alternating or continuous current systems, the cost of the power house and generating plant is the same. I venture to assert that in practice this is not the case, owing to the considerable loss of energy that has to be allowed for in the low tension feeders at the times of maximum demand. It is a point frequently urged against the high tension transformer system that with it the all day efficiency is low, and consequently the working expenses are proportionately high, for the reason that the percentage of loss is higher during the long hours of light load than during the comparatively short hours of heavy load, while with low tension the loss is only great during the short period, and is little during the long one. No doubt, so far as working costs are concerned, this is an important point against the use of alternating currents. When we come to capital cost, however, this consideration works all the other way. The power of boilers, engines and dynamos, and the house required to contain them, have to be regulated by the maximum power that they may be required to develop. Owing to the excellent efficiency of transformers at full load, and the comparatively small losses that can be insured with high tension mains, this maximum power, in the case of high tension alternate currents need, even in a place like Scarborough, be very little in excess of the power actually delivered to the lamps. With low tension, on the other hand, there is the loss in the feeders, which is greatest when the demand is most, and when, consequently, the strain on the generating plant is at its maximum.

It follows from this that in places where the distribution covers considerable distances, unless feeders of abnormal size and great cost are employed, the low tension system necessitates an appreciably greater maximum power and proportionately greater capital cost in generating plant and buildings than does the alternating high tension system.

The efficiency of any electric lighting system is, no doubt, of the utmost importance; but so is also the question of capital cost, and efficiency may be bought too dear. It is chiefly a question of interest on additional capital *versus* decreased running expenses; but it is also one of obtaining this additional capital.

After all, the proof of the pudding is in the eating, and when the balance-sheet of the Scarborough Company is made public in due course, it will be found that we have earned a substantial profit during our first year of working, a result which few low tension companies anywhere can boast of, and one which I venture to assert no low tension company could possibly have arrived at in the case of Scarborough without a very much larger capital expenditure than ours.

A. A. C. Swinton.

December 25th, 1894.

Accumulators for Traction Purposes.

Mr. Epstein is very kind in informing us of what is well known, but he does not tell us how a single per cent. can be gained. We know all about what storage cells will do; what is wanted is to get more out for a given weight and not to have such an enormous loss. I do not think the present cells give 10 per cent., if they do that. I, for one, shall be much interested to hear your reply to Mr. Epstein's remarks.

E. Hancock.

[It is difficult to follow either Mr. Hancock's percentages or his reasoning, so we simply refer him to our reply to Mr. Epstein's criticism.—Eds. Elec. Rev.]

We have received two letters on "Small Dynamos: Their Construction," which we are compelled to hold over until next week.

The Cardiff Electrical Works.

THE "CARDIFF ELECTRICAL WORKS."

Some little confusion has been created in Cardiff by the similarity in names of the recently opened Corporation works and the old-established manufacturing works of Mr. Sydney F. Walker. At a recent meeting of the Cardiff Town Council Mr. Massey, the consulting engineer to the Corporation, complained that

> Young fellows frequently called at his office, or at the electrical station, in response to advertisements stating that premium pupils were wanted for the Cardiff Electrical Works. This conveyed the impression that it was the Cardiff Corporation Works.
>
> Alderman Jacobs: Is there another Cardiff Electrical Works?
>
> Mr. Massey: I have no knowledge of any.
>
> Mr. Harpur said there was a place called the Cardiff Electrical Works in the town.
>
> Mr. Massey said a man could make a good thing out of premium pupils if he only had enough of them, but it was using the name of the Corporation Works.
>
> Alderman Jacobs said it was very misleading.

Mr. Sydney F. Walker very properly replies to this in a recent issue of the *South Wales Daily News*. We cannot do better than reproduce the letter:—

> Sir,—I am sorry that the name of my works has put the corporation to any inconvenience; we also have experienced considerable

anoyance from the numerous applicants that have applied to us for appointments. These works were named several years before anyone dreamt that the corporation would go in for a lighting station of their own, and as the works have become known to a large portion of the English-speaking world in connection with our firm, it can hardly be altered now. If there is anything, too, in the fitness of a name, surely we who have been doing all kinds of electrical work in the district for the past 20 years are more entitled to the name than the corporation, who only do a small section, viz., generate current for lighting purposes. I suggest that the corporation should name their works, "The Cardiff Corporation Electric Lighting Station," and have the name widely published, when I feel sure the trouble will cease.

I am, &c.,

Sydney F. Walker.

Cardiff Electrical Works,
December 19th, 1894.

As we have already described and illustrated the Corporation works, we may help to prevent future misconceptions by illustrating the exterior of Mr. Walker's works. Unfortunately we have no description to present to our readers. Mr. Walker's contention, however, that the works are old established seems to be quite borne out. There is, however, something in Mr. Walker's suggestion that works like the Cardiff Corporation Station, which are mere suppliers of electricity, should say so, and not lead budding engineers astray by adopting names which would suggest that they undertake general electrical work on the same scale as Mr. Walker.

NOTES.

To Our Readers.—We have great pleasure in heartily wishing our readers a happy and prosperous new year. We trust the gloom which has been overhanging the electrical industry, in common with other trades, for the past 18 months or more, is now rapidly passing away.

Reddaway and Others v. Banham and Others.—In our legal columns we give a report of the judgment on appeal in this case, which is a most important and interesting one for business men, as the question at issue was as to the right of a producer to the sole use of a generic name for an article because he was first in the field with it.

New Method of Obtaining Line Spectra.—The line spectrum of sulphur and many other bodies is usually obtained by passing a condensed spark through sulphur vapour, &c., under low pressure. It can, however, be obtained much more simply under ordinary pressure by passing a condensed spark between two platinum wires or two carbon rods, the tips of which are covered with the substance whose line spectrum is to be ascertained. If the condenser is not used, the material inflames. Various metallic sulphides may be successfully treated with the condensed spark.

"A Promised Surprise to the Electrical World."—As we said last week, the daily press gives currency to a "great electrical discovery," which is to revolutionise everything, and to produce enormous power at a trifling cost. The new primary battery, the invention of two inspired brothers of Clydebank, consumes its zinc plates at an astonishingly slow rate, and gives out immense power, in spite of the theoretical consideration that the zinc consumed in any battery cell is for a definite electromotive force and power a definite amount, a theory which stupid old scientists have had the effrontery to say has been proved over and over again; however, the two intelligent youths of Clydebank have upset all this, and have lighted an arc lamp at a Glasgow station with "one or two cells" of the battery as brilliantly as by the power supplied from the "big dynamos." "Newspaper science" has long been the scorn of scientific men, but it is nothing less than scandalous that something cannot be done when, through gross ignorance and carelessness, the public can be misled by the daily press into investing their money in concerns which, to put it very mildly, are nothing less than "wild cat" schemes. "Should these sanguine hopes be realised," says the Glasgow *Citizen*, "it will be not a mere improvement, but a revolution in electrical science of vast and world-wide importance." Doubtless this is so, but how are the public to know that these "sanguine hopes" are due either to ignorance of the grossest kind, or something worse? Glasgow seems terribly behind the times, notwithstanding that it has in its midst the technical college over which Prof. Jamieson presides. Here in London we have had periodically the concealed primary battery, the secret depolarising powder, the whirling round of the little electromotor, the working of the sewing machine, and the great feat of running an arc lamp, year after year. It seems to have escaped notice, in Glasgow at least, that previous to the invention of the dynamo, the only means of working an arc lamp was by means of a primary battery. It will be satisfactory to all good Scotchmen to learn that the battery objects to doing work on the Sabbath, and as Lord Kelvin has expressed himself as being *rather* sceptical as to there being anything in the supposed great discovery, we may conclude that the young gentleman (one of the brothers) who "has distinguished himself at school, and since in mathematics and electrical science," has landed himself in the same hole from which so many previous primary battery inventors have emerged to find they have still something to learn.

Niagara To-Day.—Prof. George Forbes, who has just returned from America, writes to the *Times* under date Niagara Falls, December 10th, as follows:—"Nearly three years ago you published a letter from this place in which I gave some account of how the dreams of the engineer were in the act of being realised, and without injury to the natural beauties of the spot. Three years have passed, my work is ended, and it seems natural to continue the narrative and tell what these three years have brought forth. I am perched on the top of a small Eiffel Tower, lately erected, and, casting my eyes up the river, over the house-tops and beyond the town, I see a new world created. There is a wide canal leading water into that gigantic power house where three turbines are set up to drive three dynamos of 5,000 horse-power each. There is the bridge to carry cables across to the transformer house. Inside the power house the water is carried down pipes 7½ feet diameter into the turbines, and thence it passes through a 7,000 feet tunnel under the town, emerging below the Falls, and capable of developing 100,000 horse-power. Far as the eye can reach extend the company's lands, with here and there a huge factory either now using the water power, or waiting for the electric supply. One of them uses 3,300 horse-power, another 300, a third one 1,500, and that unfinished mill requires 1,000. You can see, far away, the model village for working men, and improved sewage works with drainage, pumps for water supply, electric light, and well paved streets. There, again, is the dock where ships from all parts of the great lakes can unload, and there a huge expanse of reclaimed land; while the whole is swept by the company's railway, seven miles long, connecting every factory with the great trunk lines. The power is transmitted by electricity, and the first work is to produce aluminium with 1,500 horse-power. New types of machines have been devised for this work, as also for every other purpose. All criticism as to cost of electric works has been swept away by the results achieved, and the efficiency of each type of machine is greater than has been attained before. All the machinery for the first working has been made and tested in the shops, and the last parts are now being set up. The plans for carrying the power to Buffalo, 18 miles distant, are complete. In a month or two factories will be in full operation; in a year Buffalo will be supplied; in two years the same company will be working the Canadian side of the Falls, and in 10 years (shall we say?) the whole of the 100,000 horse-power which can be supplied by the existing hydraulic works will be giving power to smokeless manufacturing towns. The period of planning the transmission scheme, of designing the greatest dynamos in the world, and of construction of the first plant now closes. The financial period commences with the new year. The earning of dividends and the ordering of duplicate machinery is the future work of the company. In conclusion, it is difficult for me to say who were the boldest, the capitalists who embarked on the scheme before any plans were matured, or the manufacturers who moved their factories to this field before a single result had been achieved. The action of both was typically American, but their confidence was not misplaced. Their success is now assured."

The Western and Brazilian Telegraph Company, Limited.—The following telegram has been received from Rio de Janeiro:—"26th, Budget Bill containing purchase clauses signed by President of Republic on Christmas Day."

French Colonial Telegraphs.—Considerable progress is being made with the length of telegraph line between Grand Bassam and Hou, which is situated at the mouth of the River Bandama. A distance of 140 kilomètres has been completed. Only another 20 kilomètres remains to be done, and the work will be finished as soon as a fresh stock of wire arrives.

Electrical Fatality in Switzerland.—A workman in the employ of Messrs. Escher, Wyss & Co., Zurich, who, notwithstanding the notices placarded all about the works, and the special prohibitions of the foreman, had quite unnecessarily climbed upon the roof of the workshop, where the construction of petroleum vessels was carried on, touched the lighting cables with his head, and was instantaneously killed.

Lectures.—Mr. Henry A. Mavor read a paper, last week, before the Institution of Engineers and Shipbuilders at Glasgow, on "A New Mining Motor."

On 17th inst. a lecture was delivered in Cult's Free Church Hall, on "Electric Light and its Production," by Mr. Malcolm Walker, of the Northern Electric Supply Company. Mr. Walker will lecture on "Land and Submarine Electric Cables" on January 24th, 1895.

Muirhead v. The Commercial Cable Company.—The result of the recent appeal against the judgment in this case, delivered early in the year, is satisfactory in so far that it has borne out our contention that the judgment was against the weight of evidence, and it has also resulted in the triumph of practice over theory, for on the side of the plaintiffs were ranged scientific experts, of whose theoretical knowledge no one could venture to question the weight, but whose practical experience was distinctly limited, whilst the defendants preferred to call for the defence men who have had actual knowledge of the matters under argument, albeit their theoretical qualifications may not have been of such a high order as that of their opponents. The whole question it may, perhaps, be recollected, turned upon the use of a low resistance rheostat at the apex of the balancing bridge, which arrangement Mr. Justice Kennedy held "had undoubtedly produced better results than had ever been obtained before." We ourselves hold that this is distinctly incorrect, and that practice has proved it to be so. The appeal has resulted in favour of the Commercial Cable Company, and in our opinion justly so; but the fact remains that (if we include Mr. Justice Kennedy) two judges decided on one side and two on the other, and therefore one does not feel entirely content with the conclusion, as a settlement by the cast of a die might have left the two parties as satisfied and as convinced of the justness of the final verdict as they are at present. When one considers the extremely intricate points of endless kinds which have to be understood by those in judicial positions, one is filled with the greatest admiration for the extraordinary ability with which the subjects are grasped, and it would be surprising if mistakes were not occasionally made. Of the conscience of the "expert witness" who is ready to argue with the greatest pertinacity and assurance for the side which may be fortunate (in some cases *un*fortunate) enough to secure him, the less said the better.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Cruto Incandescent Lamp Company, Limited (41,297).—This company has filed its statutory return, which shows that out of a nominal capital of £5,000, in £1 shares, seven shares only have been taken up. There has been nothing either called or paid.

Dutton & Co., Limited (29,259).—The yearly return of this company shows that out of a nominal capital of £60,000, in 500 preference and 5,500 ordinary shares all of £10 each, 285 preference and 2,810 ordinary shares have been taken up. The full amount has been called on the 285 preference and 610 ordinary shares, and the payment accruing from these is £8,950. A total sum of £22,000 has been agreed to be considered as paid, £2,000 of which is the amount on 200 ordinary shares surrendered to the company by the vendor.

E. Wallace & Co., Limited (41,218).—The statutory return of this company, made up to October 15th last, and filed on the 22nd of the same month, shows that out of a nominal capital of £1,000, in £1 shares, seven shares only have been taken up. Nothing has been called or paid.

Railway and Industrial Syndicate, Limited (39,383).—The last return of this company shows that out of a nominal capital of £2,000, in £1 shares, 1,470 shares have been taken up, and that 5s. has been called on each. Nothing has been paid, and £367 10s. is outstanding.

BUSINESS NOTICES, &c.

Urgent.—All names, addresses and advertisements intended for insertion in the Universal Electrical Directory of 1895 should be at once forwarded to the publishers, 22, Paternoster Row, London, E.C.

Australia.—According to the *Sydney Daily Telegraph*, the intercolonial committee of electrical experts in connection with the Intercolonial Electrical Conference, was held at Melbourne early in November. Their report, which is understood to recommend uniformity of legislation in electrical matters throughout the colonies, will be forwarded to the various governments. The committee came to various decisions, which include the revision of the regulations applying to the supply and use of electricity for lighting and traction purposes.

Belfast.—The electric lighting of the Belfast Industrial Exhibition, 1895, to be opened in the Liner Hall Grounds next March, has been placed in the hands of Messrs. Wm. Coates & Son, of Belfast, to be carried out under the supervision of their electrical engineer, Mr. E. S. Dashwood. The contract includes the complete plant of steam and gas engines and dynamos, capable of supplying 100 2,000-C.P. arc lamps and 1,000 16-C.P. incandescent lamps, which are to be distributed throughout the grounds and buildings of the Exhibition. This firm are also engaged upon several smaller contracts in the city and neighbourhood.

Brighton.—Last week the Town Council resolved upon an expenditure for the extension of the electric light into certain streets.

Coventry.—Tenders for electricity meters were recently received from the following firms:—The Westinghouse Electric Company, Limited; the General Electric Company, Limited; Charles A. Muller; the Electric Construction Cimpany, Limited; Chamberlain and Hookham; the British Thomson-Houston Company, Limited. The price to be charged for current for motive power purposes is to be 4d. per Board of Trade unit.

Glasgow.—The new boilers and machinery installed by the postal authorities for the electric lighting of the building, and for working the pneumatic tubes, were tested *in situ* under steam the week before last; and on Saturday, 15th inst., the permanent lighting service was commenced. Pending the final rearrangement of the staff and office, however, only about one half the lamps will be supplied in this way until after Christmas, the remainder deriving current as heretofore from the street mains. The boilers were built by Messrs. Penman & Co., of Glasgow, and are of the Lancashire type. They are fitted with Vicars mechanical stokers. There are three 50-kilowatt Willans-Crompton steam dynamos, and two 50-H.P. Paxman horizontal engines for the air compressors. Messrs. D. Stewart & Co., of Glasgow, are responsible for the steam and other pipe work, pumps, &c., and the fine installation of 54 Brockie-Pell arc lamps, together with some 120 glow lamps, has been carried out by Messrs. J. and G. Graham, of Manchester. Mr. E. G. Rees is the engineer in charge under Mr. Ashton, the superintending engineer of the West Scotland district postal telegraphs.

Hampstead.—On Tuesday last week, an important extension took place, the premises of several tradesmen in the High Street being lighted by electricity for the first time.

Harrow.—A contemporary states that "in consequence of the decision of the public meeting held to consider whether or not the Board should go forward with the electric light scheme, the Local Board at their last meeting resolved to sell the right of the provisional order granted a few months ago to Messrs. Crompton and Hawtayne on the condition that these gentlemen pay the full cost the Board have been put to to secure the order. Messrs. Crompton and Hawtayne offered £300 for the provisional order, and agreed to sell the plant, &c., to the Local Board in seven years if the Board then desired to light the town themselves, subject, of course, to certain conditions.

Hove.—The surveyor, at the last meeting of the Commissioners was instructed to prepare a report regarding the advisability of lighting Church Road and some of the other principal thoroughfares of Hove by electricity.

Islington.—Members of the St. Luke's Vestry are complaining of the nuisance caused by the streets being opened for laying the electric light mains.

Leicester.—The Corporation electric lighting scheme is now complete. On 20th inst. the electric light was turned on in several shops with which the connection has been made. Some of the mains for the electric light are not yet laid, but the installation is sufficiently advanced to enable the corporation to keep up the supply where the fittings are completed.

Maidstone.—A member of the District Council has given notice that at the next meeting he will propose that the provisional order be put out for tender, as it is evident the Council intend doing nothing with it themselves.

Business Announcement.—Mr. John Oliver, 50, 51, and 52, Great Sutton Street, E.C., informs us that he has sold the business of Newington, Priddle & Co., lately carried on by him, to Mr. R. K. Sinclair, of 20, Coleman Street, E.C. All accounts owing or outstanding to December 8th will be paid or received by Mr. Oliver.

Change of Address.—The St. Martin's Electrical Manufacturing Company, Limited, inform us that they have removed their works to more extensive premises at 44, Blythe Road, West Kensington, where they are putting down improved plant to deal with their increasing business. The office of the company is to remain at present at 6, Adam Street, Strand.

Electric Avenue.—The Electric Avenue at Brixton was illuminated from the evening of the 18th inst. to Tuesday last on a much more extended scale than any of the previous Christmas illuminations produced there. The lighting of the street, which is about 600 feet long by 44 wide, was produced entirely by Fyfe-Main arc and Edison-Swan incandescent lamps, which combined, exceeded 100,000 candle-power. The colonnade of the Avenue was decorated with trees, and the pillars supporting the new covered way were entwined with foliage; festoons of incandescent lamps, representing water lilies, were artistically looped across the roadway. In addition, there were a number of trees fronting Brixton Road, illuminated with lamps enclosed in flowers of the same kind, only different in colour. The decorations and electrical effects were originated and planned by Mr. A. L. Fyfe, of Brixton, and were carried out under his personal supervision.

Iron and Steel Trade in 1894.—Messrs. Bolling and Lowe, in their annual "Trade Review," say that the iron, steel, and allied industries of the year 1894 opened with bright prospects, but they only lasted for a short time, and then business lapsed into its former languid condition. "The 'Light Railways' question has lately been taken up strongly in the Press, and is attracting great attention, but we fear that an early development of the project will be deferred, as the Board of Trade is prevented by its regulations from facilitating progress, without reference to Parliament and consequent delay, even if other political matters do not interfere with giving the subject a fair hearing. Cheap road railways—£2,000 per mile—are more likely to meet urgent necessities, whereas light railways would in many respects, in the first instance, be more of a convenience than a commercial success. We take credit for having advocated this important matter for more than 20 years. The fact that prices of iron and steel in 1894 have barely shown any variation, in face of decreased exports, must be taken as a most encouraging sign, and we can hardly believe that when a change does take place it will be other than an improvement."

M'Carthy v. Letts.—Before the Recorder of Belfast, the other day, this—a remitted action—was heard. Prof. E. A. Letts, of Queen's College, Belfast, was sued by C. C. M'Carthy, an electrical engineer, to recover £22 5s. for erecting wiring for 100 arc lamps, one Brockie-Pell and one French arc lamp. It was decided that Prof. Letts was not responsible.

Presentations.—Mr. R. Johnson, chief of the office staff of the Electric Construction Company at Wolverhampton, was on the 17th inst. presented with a marble clock from his fellow employés, a purse of gold from the directors, and a gold ring from several friends, on the occasion of his marriage.

Mr. G. W. Spencer Hawes, secretary and general manager of the Brighton and Hove Electric Light Company, Limited, was last week the recipient of a marble clock and side ornaments, also an illuminated address, from the staff, employés, and friends, as a memento of his connection with the company, which has now closed its works, the whole business having been transferred to the Corporation.

Price Lists, &c.—From the Crypto Works Company, Limited, of Clerkenwell Road, E.C., we have received a copy of their new illustrated price list. Motors of various types, small dynamos, and hand feed focussing arc lamps are described and clearly illustrated. The catalogue is nicely got up, and is neatly printed.

Mr. John Spencer, of Wednesbury, has sent us an 1894 list of his iron and steel tubes and accessories.

Small Dynamos—Their Construction.—Messrs. M. E. Austin & Co., of Armley, Leeds, write us as follows:—Under this heading, last week, you say that "There is a limit to the small size of dynamos, below which they will not excite themselves. Also, that there is very little use for very small machines. We think the writer of this article is too cocksure. With regard to the first part. We make a large number of dynamos, that only weigh, complete, 10 lbs. These machines give out fully 50 watts for useful work, and only absorb 10 watts in the armature and 10 watts in the field magnets. Thus, for 70 watts generated, 50 watts are available for useful work. We consider this rather upsets the theories of mathematicians, who generally try their experiments on paper. If the writer cares to give us an order, we are prepared to make a perfectly self-exciting dynamo that shall weigh only, all complete, 1 lb., with an output of 2 to 3 watts. Our No. 1 'Infant' dynamo gives out 50 watts as stated, and works in practice equally as well as the largest dynamo made. This machine has only 6 to 8 ounces of wire on the armature (which is a Gramme ring), and 1¼ to 1½ lb. on the field magnets, and runs at about 2,800. Some of them have been running for 12 and 16 hours a day for from five to eight years, without the slightest mishap. The limit to the small size of a self-exciting dynamo depends almost entirely on the quality of workmanship and material; and during our experience, so far, we see no reason why one could not be made sufficiently small to hang on the end of a watch guard for ornament."

South Staffordshire Tramways.—We understand that on Friday last a conference was held in London, convened by the Mayor of Walsall, between the South Staffordshire Tramway Company and the Electric Construction Company, and an agreement was then come to regarding the resumption of the traffic. In consequence, the electric cars started running on the afternoon of the same day. The inconvenience caused by the stoppage of the cars is said to have been very great, and the resumption of the service has given satisfaction in the districts.

Speed Indicators.—With reference to the correspondence we have published on this subject, Messrs. Burbey, Williamson and Joseph state that they have on sale a speed indicator such as would suit our correspondent. They are on show at the offices, 92, Queen Victoria Street.

The Arcas Plating Company, Limited.—At an extraordinary general meeting of the above company held on November 21st, 1894, at Winchester House, Old Broad Street, E.C., resolution number (1) was passed, and at a meeting held at the same place on December 19th, 1894, the said resolution was duly confirmed, and also the following ordinary resolution number (2) was passed:—1. "That it has been proved to the satisfaction of this company that the company cannot by reason amongst other things, of their inability to obtain payment from several of the largest subscribers of the application and allotment money due on shares, continue its business, and that it is advisable to wind up the same, and that accordingly the company be wound up voluntarily under the provisions in that behalf of the Companies Acts, 1862 to 1890. 2. That Mr. Herbert James Pratt, F.C.A., of 9, Old Jewry, in the City of London, and Mr. Claud Scott be appointed joint liquidators of the said company at a remuneration of £100, in the proportion of £75 to Mr. H. J. Pratt and £25 to Mr. Claud Scott."

Tramcar Lighting.—Dundee tramcars are to be lighted by electricity. The system is to be about the same as that which is being adopted at Glasgow.

CONTRACT CLOSED.

Taunton.—The Town Council have resolved to order from the Fowler-Waring Cables Company the necessary cables, &c., for making the house connections in connection with No. 2 substation. The cost is £681.

CITY NOTES.

Anglo-Portuguese Telephone Company, Limited.—The coupons No. 14 of the first mortgage and No. 9 of the second mortgage debentures will be paid, less income tax, by Parr's Alliance Bank on and after 1st prox.

The City of London Electric Lighting Company, Limited.—The allotment letters and letters of regret, in respect of the issue of £200,000 debenture stock, have been posted.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending December 23rd, 1894, amounted to £968; week ending December 24th, 1893, £952; increase, £16; total receipts for half-year, 1894, £22,447; corresponding period, 1893, £21,049; increase, £1,398.

The Liverpool Overhead Railway Company. The traffic receipts for the week ending December 23rd, 1894, amounted to £938; corresponding week last year, £604.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending December 21st, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,141.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, December 19th.	Closing Quotation December 22nd.	Business done during week ended December 22nd, 1894. Highest.	Lowest
173,400/	African Direct Teleg, Ltd., 4 % Deb.	100	...	...	...	102 —105	102 —105	...	...
1,012,880/	Anglo-American Teleg., Ltd.	Stock	£2 12s.	£2 15s.	£2 11s.	38 — 39	38 — 39	...	...
2,993,560/	Do. do. 6 % Pref.	Stock	£5 5s.	£5 10s.	£5 2s.	71½— 72½	71½— 72½	72¼	71¾
2,993,560/	Do. do. Defd.	Stock	...	...	...	6¼— 6⅝	6¼— 6⅝	...	...
130,000	Brazilian Submarine Teleg., Ltd.	10	8 % §	6¼ % §	6¼ % §	10⅝— 11¼	10⅝— 11¼	11⅛	11
75,000/	Do. do. 5 %, repayable June 1906	100	...	...	...	111 —115	111 —115	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 40,000	5	... §	10%‖ §	... §	2 — 3	2 — 3	2½	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	140 —150	140 —150	...	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	3½ % §	2 % §	2 % §	1/16— 1/8	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	12½— 13½	12½— 13¼	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	20	...
12,931	Direct Spanish Teleg., Ltd., £4 paid	5	4½%	4 %	4 %	4¼— 4⅜	4¼— 4⅜	...	...
6,000	Do. do. 10 % Pref.	5	10 %	10 %	10 %	9¼— 9⅜	9¼— 9⅜	...	...
30,000/	Do. do. 4½ % Debs of £50, Nos. 1 to 1,600	...	...	...	...	105 —108%	105 —108%	...	...
60,710	Direct United States Cable, Ltd., 1877	20	3½% §	3½% §	2⅜% §	8¼— 8⅛	8¼— 8⅜	...	...
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½% §	6½% §	6½% §	15⅞— 16⅛	15⅞— 16⅛	16⅛	16
70,000	Do. 6 % Pref.	10	6 % §	6 % §	6 % §	16¾— 17¼	16¾— 17¼	16 15/16	16 13/16
102,100/	Do. 5 % Debs., repay. August, 1899	100	...	...	...	106 —110	106 —110	..	...
1,297,837/	Do. 4 % Mort. Deb.	Stock	...	...	...	119 —122	119 —122	...	...
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7 %	16 — 16¼	16 — 16¼	16¼	...
54,100/	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	...	...	...	103 —107	103 —107	...	...
194,300/	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	...	...	...	104 —107	104 —107	...	...
320,000/	Do. 4 % Deb. Stock	Stock	...	...	...	118 —122	118 —122	...	...
95,100/	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	...	...	...	103 —107	103 —107	...	...
129,100/	Do. do. do. to bearer, 2,344 to 5,500	...	...	...	...	104 —107	104 —107	...	...
300,000/	Do. 4 % Mort. Debs. Nos. 1 to 2,016, red. 1909	100	...	...	...	105 —108	105 —108	...	...
200,000/	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	...	...	...	108 —111%	109 —112%	111	...
180,227	Globe Telegraph and Trust, Ltd.	10	5¼% §	4⅞% §	4⅝% §	8¾— 9	8¾— 9	9	8 15/16
180,042	Do. do. 6 % Pref.	10	6 % §	6 % §	6 % §	15⅞— 16¼	15⅞— 16¼	...	...
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜% §	8⅜% §	8⅜% §	21¾— 22¼	21¾— 22¼	...	...
190,000/	Do. do. do. 5 % Debs.	100	...	...	...	105 —108	105 —108	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10 %	47 — 49	47 — 49	...	...
37,548	London Platino-Brazilian Teleg., Ltd.	10	...	...	...	5 — 7	5 — 7	...	...
100,000/	Do. do. 6 % Debs.	100	...	...	...	102 —106	102 —106	...	...
15,000	Monte Video Teleph. Co., Ord., 1 to 15,000	5	...	...	...	¼— ⅜	¼— ⅜	...	...
28,000	Do. do. 6 % Pref., 1 to 28,000	5	...	...	...	1⅛— 2⅛	1⅛— 2⅛	...	...
484,597	National Teleph., Ltd., 1 to 438,984	5	6 % §	5 % §	5 % §	5⅛— 5⅜	5⅛— 5⅜	5 5/16	...
15,000	Do. 6 % Cum. 1st Pref.	10	...	...	...	15 — 17	15 — 17	...	...
15,000	Do. 6 % Cum. 2nd Pref.	10	...	...	...	15 — 16	15 — 16	15⅜	15¼
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 90,950	5	...	...	...	5⅜— 6	5⅜— 6	...	...
1,000,000/	Do. 4½ % Deb. Stock Prov. Certs. ...	...	...	...	...	110 —113	110 —113	...	...
48,800	New Teleph., Ltd., 25,901 to 74,700; £4 paid	10	...	...	...	... ...	... ...	...	...
171,504	Oriental Teleph. & Elec, Ltd., Nos. 1 to 171,504, fully paid	1	...	...	...	7/16— 9/16	7/16 — 9/16	...	...
100,000/	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	...	...	...	105 —108	105 —108	...	...
11,839	Reuter's Ltd.	8	5 %	5 %	0 %	2 — 4	2 — 4	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	109 —114	110 —115	114½	112
58,000	United River Plate Teleph., Ltd.	5	...	...	...	1 — 2	1 — 2	...	...
146,733/	Do. do 5 % Debs.	Stock	...	...	...	88 — 94	88 — 94	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	4 %	..	0 %	3 — 5	3 — 5	...	...
238,300/	Do. do. do. 5 % Debs.	100	...	...	...	101 —104	101 —104	...	...
30,000	West Coast of America Teleg., Ltd.	10	...	...	...	1½— 2½	1½— 2½	...	...
150,000/	Do. do. do. 8 % Debs., repay. 1902	100	...	...	...	100 —105	100 —105	...	...
64,245	Western and Brazilian Teleg., Ltd.	15	4 %	2½%	2½%	11½— 12	11⅛— 11⅜	11½	11⅜
33,129	Do. do. do. 5 % Cum. Pref. ...	7½	...	...	...	6¼— 6⅜	6⅛— 6⅜	...	...
33,129	Do. do. do. 5 % Def.	7½	3 %	...	...	5 — 5½	4⅞— 5⅛	5 5/16	5
171,900/	Do. do. do. 6 % Debs. "A," 1910 ...	100	...	...	...	101 —105	101 —105	...	...
214,800/	Do. 6 % Mort. Debs., series "B," red. Feb. 1910	100	...	...	...	101 —105	101 —105	...	...
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	⅜%	1 — 1¼	1 — 1¼	...	...
34,563	Do. do. do. 6 % 1st Pref. ...	10	...	...	...	10⅜— 11⅛	10⅜— 11⅛	...	
4,669	Do. do. do. 6 % 2nd Pref. ...	10	...	...	..	9 — 10	9 — 10	...	...
80,000/	Do. do. 5 % Debs. (1917) No. 1 to 1,000	100	...	...	...	109 —112	109 —112	...	...
$1,211,000	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	...	...	...	112 —118	112 —118	...	...
166,900/	Do. do. 6 % Ster. Bonds.	100	...	...	...	102 —104	102 —104	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	...	5 %	4½%	4¼— 5⅛	4¼— 5⅛	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	...	...	...	14 — 15	14 — 15	14⅜	14 9/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	...	6 %	6 %	14¾— 15¼	14¾— 15¼	15⅛	15 1/16
100,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	...	...	...	132 —135	132 —135	...	...
56,000	†Liverpool Electric Supply, all paid	5	4½%	5 %	5 %	7⅜ — 7½	7⅜ — 7⅜	7½	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	1 %	2 %	2½%	9¾— 10¼	9¾— 10¼	10 3/16	10
100,000/	Do. 5% Deb., bonds of £10, £20, £40	...	...	...	...	... — ...	... — ...	...	...
150,000/	Do. 4½% first mortgage debenture stock	...	...	...	...	115 —117	116 —118	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	...	...	...	7 — 7½	7¼— 7⅜	7⅜	...
19,980	St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-18,780	5	8½%	7½%	4½%	7⅜— 8¼	7⅜— 8¼	8	7 15/16
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	8¼— 9	8½— 9	...	...
59,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	...	3½%	4 %	7 — 7½	7 — 7½	7⅜	...

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. § Dividends paid in deferred share warrants, profits being used as capital.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1891.	1892.	1893.	Closing Quotation, Dec. 19th.	Closing Quotation, Dec. 22nd.	Business done during week ended Dec. 22nd, 1894. Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000	3	...	6 % §	6 % §	2⅜ — 2⅝	2¼ — 2⅜	2 9/16	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	...	6 % §	6 % §	2⅜ — 2⅝	2⅜ — 2⅝	...	...
125,000/	Do. do. 4½ % Deb.	Stock	...	...	...	111 —114	111 —114	...	...
630,000/	City and South London Railway	Stock	...	⅝%	⅝%	42 — 44	42 — 44	...	...
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	7 % §	7 % §	7 % §	2¼ — 3¼	3 — 3½	...	...
50,000/	Do. do. 5 % 1st Mort. Debs., 1—400 of £100, and "A" 1—200 of £50 each	...	...	...	...	97 —102	97 —102	...	...
120,000	Electric Construction, Ltd., 1 to 120,000	2	...	...	...	¼ — ½	¼ — ½	...	...
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	...	...	...	1½ — 2	1½ — 2	...	...
100,000	Elmore's French Patent Cop. Deposg., Ltd., 1 to 66,750 ...	2	*nil*	*nil*	*nil*	1/16 — 3/16	1/16 — 3/16	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil* ¶	*nil*	*nil*	1 — 1¼	1 — 1¼	1⅛	7/8
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	*nil*	*nil*	¾ — 1	¾ — 1	⅞	¾
20,000	Fowler-Waring Cables, Nos. 301 to 20,300	5	*nil* §	*nil* §	*nil* §	½ — 1½	½ — 1½	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	7 %	...	...	6½ — 7½	6½ — 7½	...	...
6,837	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	5 %	5 %	5 %	8½ — 9½	8½ — 9½	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	12½%	12½%	12½%	25½ — 26½	25½ — 26½	26¼	...
200,000/	Do. do. do. 4½ % Deb., 1896	100	...	...	...	102 —104	102 —104	...	...
37,500	†Liverpool Overhead Railway, Ord.	10	...	...	1 %	8⅛ — 8¾	8½ — 8⅝	...	...
6,295	† Do. do. Pref., £8 paid	10	...	...	...	13 — 13¼	13 — 13¼	...	...
	Swan United Electric Light, Ltd.	...	11 % §	10 % §	7½% §	... — ...	... — ...	...	...
37,250	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	20 %	41 — 43	41 — 43	41⅜	...
150,000/	Do. do. do. 5 % Bonds, red. 1894	100	...	...	...	106 —109	106 —109	...	...
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £2 paid ...	10	...	...	...	2¼ — 2½	2¼ — 2½	...	...

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50 % for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (fully paid), 5⅜—6.
Charing Cross and Strand Electricity Supply Corporation, £57,400—5 % Debentures.
Electric Construction Corporation, 6 % Debentures, 93—97.
Electric and General Investment, shares of £5 (£1 paid), 1¾—2¼.
House-to-House Company (£5 paid), 2¼—2½.
Do. do. 7 % Preference, of £5, 6¼—6⅝.
Do. do. 6 % Debentures of £100, 101—103.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 4⅜—5¼; 1st Preference Cumulative 6 %, £5 (fully paid), 6¼—6⅝.
Liverpool Electric Supply, £5 (fully paid), 6⅜—6½.
London Electric Supply Corporation, £5 Ordinary, ⅞—1¼.
Queen Anne's Mansions Lighting and Heating Company, 6 % £100 Debentures, 101—103.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares (£4 10s. paid), 4¼—4⅜.

Bank rate of discount, 2 per cent. (February 22nd, 1894).

SOME TESTS OF THE MAGNETIC QUALITIES OF GUN STEEL.

Lieut. George O. Squeer, Ph.D., Third Artillery, U.S.A., has just published in the U.S.A. *Journal of Artillery* some tests on gun steel, the results of which are interesting.

The sample tested was in the form of a ring cut from the muzzle of a gun, and was tested in the usual way for rings. One curve shows saturation at B=16,000 with H=47, that point is just over the bend in the curve, the bend beginning at B = 13,000, H = 20. The following are the figures for the H B tests:—

Values of H.	Values of B.
113·22	18,052
98·25	17,652
90·63	17,293
78·27	16,975
65·32	16,581
56·61	16,262
42 93	15,754
32·25	15,000
21·44	13,664
15·32	12,478
13·50	11,770
11·15	10,503
7·30	6,407
3·40	537
1·68	216

RESULTS.

The foregoing very superficial tests indicate that the steel of our new guns, besides possessing remarkable physical qualities, also has excellent magnetic qualities, and, but for the cost, could be used for the construction of electrical machinery with very efficient results. In fact a comparison of the figures given in the above table with Hopkinson's curve for the best wrought-iron shows them to be practically the same in character, and when further compared with the curves for the average steel *castings* from various manufacturers in the United States, we find magnetic values about 8 per cent. in favour of gun-steel. This indicates an improvement produced by forging as compared with simple steel castings, and for marine dynamos, and in gun-training motors where space is valuable, steel of high permeability will, probably, be exclusively used in the future.

Steel is now much used on this side for magnets, and is likely to be more than ever used for alternators and motors, where the form of the field would otherwise entail costly construction. Castings of any practicable form can be got easily.

PURIFICATION OF ACETIC ACID.

WE extract from the Russian paper *Elektritshestvo* (Electricity) the following notes on a new application of electricity:—

"The usual process for purifying acetic acid consists in distilling the raw acid by steam in copper rectifiers, but this mode of operating does not yield pure acid, owing to the formation of acetate of copper. This is a great drawback, especially in the manufacture of colours, because the slightest trace of acetate of copper spoils the tints of certain colours, such as red and rose alizarine. Moreover, the rectifying process is rather expensive, not only on account of the cost of steam power, but because the copper apparatus being rapidly attacked by the acid require frequent repairs and renewal.

"At the end of 1892 a Russian engineer, M. Ph. A. Eremine, proposed to Messrs. V. Lepeshkine & Sons, manufacturing chemists at Tranof-Voznezenka, to work a process of purification of acetic acid by electricity; the offer was accepted, the installation started, and in 1893, more than 30,000 pouds (61 pouds = 1 ton) of electrically purified

acetic acid were sold with such a success, that the old copper rectifying apparatus were abandoned." The Russian paper does not give any details on the new process which Mr. Eremine keeps secret until he has obtained his patent, but tells only that the apparatus which is called the electro-extractor is a box, 20 times smaller than the copper still; the box is hermetically sealed, and through the lid the raw acid enters at one end and flows out quite pure at the other end; the current passes through the box by means of insulated wires.

The process is cheap, rapid, and it appears that the quality of the electrically purified acid is superior to that of the usual acetic acid, as it does not contain copper nor products of distillation, such as formic acid and methylated spirits, and therefore has no fiery and unpleasant smell. Being free from suffocating smell, this electrically purified acetic acid is especially advantageously used in the cotton printing factories where it is not noxious, as the ordinary rectified acetic acid.

In our opinion, this mysterious box is nothing else than an imitation of the platinum apparatus, invented by Messrs. Johnson and Matthey, which works so remarkably well for the concentration of sulphuric acid and other liquids by heat generated by electricity, and which consists of a platinum rectangular pan, fitted internally with insulators, holding the necessary platinum heaters.

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Discussion on Electric Traction.

(*Continued from page 756.*)

* Mr. S. Z. de Ferranti said the impression produced on his mind by the various most interesting papers which had lately been read to the Institution on traction was that whatever other countries had done, we over here had done very little. It was an unfortunate state of affairs, and it might be interesting to consider for a moment what were some of the probable causes which had led to this backwardness. In the first place he thought they had a very exaggerated idea of the hideousness of an overhead system. This was a very unfortunate thing, because the overhead system appeared to have been proved to be quite the cheapest way of working for the largest number of applications in the way of running tramways in and about our towns. This had been proved undoubtedly to be the best system for the purpose commercially, and therefore it was one which ought to receive the very greatest consideration, and one which was likely to come first, if other objections were put on one side. With regard to this objection of unsightliness, no doubt still further improvements would be made which would render the lines better looking, and he had no doubt that, being accustomed to seeing them, they would forget that they were ugly, and think rather of the great convenience they would give. The second great trouble appeared to him to be that of fire escapes. Perhaps in America the houses were too high to make it worth while trying to save people by fire escapes; but however that might be, in this country most people he had spoken to had met him with this difficulty, that the wires were in the way of fire escapes, and therefore an overhead system could not be tolerated. To meet this difficulty, he would suggest that electricians should re-invent, re-design, and give for nothing to the various authorities fire escapes which could be worked without interfering with the overhead lines. The next question was that of danger, and that, he thought, was far more fancied than real. No doubt accidents might occur through overhead wires dropping, but they were infrequent, and that was not a difficulty which should be set against the immense advantages which would come from rapid traction in our towns. There was another thing which had militated very much against the development of electrical tramways, namely, the obstructions which had been put in their way. Perhaps he was not right in calling them obstructions, but we had a custom here of always protecting the man in possession. That was to say, if there was an existing industry, say, for example, the telephone industry, the whole legislation tended to protect that particular industry, and to see that the coming one, however beneficial and important, did nothing to interfere with the existing one. Account did not seem to him to be taken of the fact that both industries should contend together to protect themselves. He thought this was very notable some little time ago, when every provision was made for the existing industry, and every difficulty put in the way of the new one. He was afraid this was one of the troubles they would suffer from a great deal. Then there was another thing, and he feared a far greater trouble. They knew that everything of a new nature required an immense amount of personal effort and continual work to bring it forward. Electric traction required all the energy of the whole electrical industry, whether they were strictly interested in this particular branch or not. Too much could not be done in this way in order to make matters progress, but he fancied that the primary power in moving people towards pushing electric traction forward was absent, in the fact that there were no particular systems so far as he knew in this country, which were the particular property of different individuals with capital at their command, or different manufacturing corporations. That was to say, it was not the particular business of any several sets of people to push any particular system of electrical traction with the public, and, therefore, he thought that one of the great inducements, namely, personal gain, was absent in this particular case. He thought that very likely this might have a good deal to do with there not being that great effort made in this country which was necessary to introduce such a thing as electrical traction as largely as it should be introduced. It might be possible a little later on to form some sort of association for this purpose, or for some committee—possibly, of that Institution—to be formed which should receive reports, primarily, from all interested parties; that was to say, people who would be directly influenced by the progress of electric traction, principally manufacturers and people who had something to sell. Then might come the turn of those not directly interested. He reckoned all those there present were interested directly or indirectly. Although they might do nothing in electric traction themselves, they could not do better than help those who were interested in electric traction, because it would tend to an improvement of their own work by filling up the shops of those who did electric traction work, and improving the prices generally for those not particularly interested in this particular branch. He was afraid this question was rather outside the scope of a scientific society, but it had a right there, because anything that conduced to the general spread of electricity must certainly increase the amount of scientific knowledge on the subject, and the work which professional people would do as the result, would greatly add to the general benefit which might be obtained by everyone from the widespread applications of electricity to various purposes.

* Mr. A. Sharp said there was one point in Dr. Preller's paper on which he would like to make a few remarks. Referring to the effect of the varying traffic, and especially in starting cars, he had said the most effectual remedy was the use of an accumulator battery which absorbed any excess of supply in the generator over demand in the line, and made up for any deficiency of supply, so that the steam engine and generator could always run at full and constant load. He would like to call attention to the merits of an ordinary fly-wheel as a means of storage of energy for the particular purpose of electric traction. Energy stored up in a moving body was proportional to the weight and square of its velocity, so that if they could increase the velocity of the rim of the fly-wheel, they would get a considerably greater increase in the energy stored. He hoped to point out before he had done that they had not reached the safe limit of speed for fly-wheel rims. Suppose they made a fly-wheel with a rim velocity of 300 feet per second. One pound weight of rim would consume 95 horse-power minutes, and with an effective velocity of only 5 per cent. above and below the average, the available energy would be 19 horse-power minutes; that was, a fly-wheel of 10 tons weight running at that speed, and with a 5 per cent. variation of velocity, would give 190 horse-power minutes available to meet the excess and deficiency of energy. At present, with the ordinary construction of fly-wheel, the safe speed seemed to be about 100 feet per second. Our American cousins ran things much closer than we did in this country in running fly-wheels at high speeds, and they, unfortunately, seemed to get a good many cases of fly-wheel accidents. Now, the breaking of fly-wheels was usually attributed to the severe centrifugal stresses on the rim. What were the facts of the case. If they treated the rim of a fly-wheel for a moment as a circular ring rotating about its centre, then, of course, there were centrifugal forces acting radially outwards at every point. Those forces produced circumferential stress on the rim, so that considering the equilibrium of the upper portion of the wheel, they had the resultant radial centrifugal forces balanced by the tension stresses on those two sections of the rim. At the speed he had mentioned of 100 feet per second, the centrifugal stresses was less than half a ton per square inch, but in large fly-wheels with a small number of arms they had quite a different state of things. They had in a fly-wheel with, say, eight arms, an intense radial force directed inwards, so that the segment of the rim between the arms was in the condition of a beam loaded uniformly and supported at the ends. Now, the bending moment of any beam loaded with load w per foot-ton is proportional to $w\,l^2$, l being its span. The bending moment then could be reduced by reducing the span of the beam, so that if they doubled the number of arms the bending moment was reduced one-fourth, and if the number of arms was quadrupled the maximum bending moment on the rim was reduced to one-sixteenth. Now, the solid disc fly-wheel to which Captain Sankey had referred was in this respect very much better than a fly-wheel made with six or eight arms. If he might be allowed, he would describe a fly-wheel which he had invented, and which had been described in some of the technical journals, and which offered certain advantages. In his fly-wheel he replaced the ordinary cast-iron arms by a number of spokes of mild steel, and he arranged them tangentially in somewhat the same method as the tangential spokes of a bicycle wheel were arranged. But the method of construction was essentially different from that used in bicycle construction. He formed a pair of spokes from one piece of steel, the middle portion passing round the nave and the ends being fastened to the rim by nuts in the ordinary way. There was absolutely no fastening of the spokes to the nave except that due to friction, so that the construction was decidedly cheaper.

* Mr. J. D. Dallas said it was not perhaps generally known that one of the principal reasons for the great advance of electrical traction in America was on account of the gearing they had adopted. In Richmond, Virginia, on the first electrical tram-road, Sprague placed single reduction gears on his motor, and because that was not successful, he arrived at the conclusion that traction was not a success; but when the gearing was altered to double reduction, that was to say, with two pinions and two gears, the road became a great success. The fault did not lie really with the gear, but with the motor, which was not strong enough to do the work. Double reduction motors then became the vogue until 1891, when he thought nearly every road in America began to operate with double reduction motors. He saw on the wall a drawing of the original motor belonging to Bentley-Knight. Those motors had two pinions and two gears, the intermediate gear was a solid gear forced on the axle by hydraulic force, and the gear on the axle was a split gear of cast-iron. In each case

* Those marked with an asterisk have corrected their remarks in proof.

the teeth were very carefully cut out in milling machines. There were great losses in these gears, amounting to as much as 15 per cent. The loss in the gear varied from the maximum, that was to say, there was some load on every motor when the whole useful work was taken up in the gear. By the introduction of single gear motors these losses, which had amounted to 15 per cent., were immediately reduced to 6 per cent. for all working loads, that was to say, from about when the motor was delivering about 5 horse-power up to a point where it was delivering its maximum of about 15, the loss in the gear, which was about 6 per cent., did not vary at all, that was to say, a good gear running in a gear cover, and fairly well lubricated. Many different forms of pinions had been used. Bronze pinions were about as good as could possibly be used for reducing the loss, and also for the reduction in noise; hide gears at one time were thought to be excellent things, and were used for a short period only, because they rapidly fell to pieces. The next improvement was to laminate the raw hide pinion by successive layers of raw hide and sheet steel or iron. But these as soon as the edge was slightly worn down cut the gear like so many saws, and they were rejected. At present, preference lay between forged steel, milled out, and bronze. For himself he had made many experiments. He was in the testing department of Thomson-Houston for a long time, and he thought they had come to the conclusion that there were smaller losses from a cast-iron gear than in any other form, the cast-iron being close-grained, and with a considerable quantity of wrought-iron scrap mixed with it. This gave a very strong gear, which worked very well. He could give an illustration of the strength of these gears. He once saw a nut dropped by mistake into the gear, which was running at 900 armature speed. The nut was dropped in between the cast-iron teeth and a pinion. No mark could be discerned on the cast-iron, but the nut was very plainly stamped on the steel, and the axle box was broken. One other point was with regard to gearless motors. These were scarcely ever of any use for street traction purposes; it was almost impossible to make a motor which had a satisfactory efficiency. He had heard very little mention of carbon brushes; he saw them used on one of the first roads ever worked in Boston, and there the commutators used to be torn to pieces in a few days before the introduction of carbon brushes.

*Mr. H. D. Wilkinson, in replying, said so much ground had been covered in the discussion that it was impossible in the time at his disposal to go into all the details that had been raised. The discussion that evening had had a most important practical bearing, but he must not forget to allude to the discussion which took place at the last meeting. He could not refer to every speaker, but he should like to have a dig at Mr. Holroyd-Smith in a friendly way. Mr. Smith had brought before them points which he had invented and carried through successfully in Blackpool, and he was sure as Englishmen they had reason to be proud of this conduit system, more especially as, he thought, there was a great future for a conduit system for cities. In the discussion that evening the overhead system had been referred to frequently, and various devices for preventing unsightliness had been referred to. More particularly they had heard of the South Staffordshire line, which he considered a most successfully planned overhead system. He must not forget to mention that he could not dismiss in the same way that Mr. Smith had done, the conduit system to which he had referred as being a practical success in Washington. He was very much struck with that conduit system. He travelled and saw it run smoothly and perfectly. Looking into the mechanical details, he saw that the expansion of the copper conductors was beautifully provided for. He also looked at the construction of the line, the manholes, the yokes, and the whole of the arrangements, and he could only say that it gave him great satisfaction, and he thought the Institution should not be kept in ignorance of that particular system. With regard to the remarks which had fallen from General Webber, he thought they had opened an entirely new field. Where the traffic was not sufficient to support a central station and to make it pay, it seemed it was quite possible, with accumulators charged at intervals, for a line to be brought to practical success. The remarks which had fallen also from the President of the Tramways Institute were very full of suggestiveness and practical value. This applied to all the speakers who had taken part in the discussion; but he must ask, as the hour was late, permission to communicate his detailed replies in writing.

Mr. Dawson, replying on his own and Mr. Blackwell's behalf, said, the time being short, they would ask permission to print their answer to the various points raised, and spare them the somewhat lengthy tables which had been compiled. As Mr. Mark Robinson has said, the financial test was the only real one. From a careful analysis of a large number of electric railway accounts, they found that the average working cost per car mile, exclusive only of interest on capital, was approximately 6½d. in America and 5½d. in Europe, and that the ratio of working expenses to receipts in both countries was approximately 60 per cent. In contrast with this, they had the working costs per car mile of the horse and steam tramways as being 10d. per car mile, and the ratio of expenses to receipts over 80 per cent. In the State of Massachusetts, U.S.A., the capital invested in street railways in 1888 (the year preceding the introduction of electricity as motive power) was £2,251,602, and the average dividends paid were 5·74 per cent. By the end of 1893 the capital invested had risen to £5,349,272, and the average dividends to 6·63 per cent. In 1888 the average ratio of operating expenses to receipts was 81·07 per cent. This had decreased in 1893 to 69·26 per cent. The net earnings in 1888 were 2·78d. per car mile. In 1893 they were 4·82d., or nearly double. The net earnings per passenger carried in 1888 were 0·78d. The total track mileage in 1888 was 534 miles, all horse or steam. In 1893 it was 874 miles of track, of which 711 miles were electric. The total capitalisation of track was £11,000 per mile in 1893. It must be borne in mind that the introduction of electricity virtually meant the entire reconstruction of many existing roads, and heavy sums being paid to obtain extended franchises; besides which, the first electric roads were largely experimental, and were practically entirely re-equipped. They thought those figures should carry conviction. The best and most recent American practice was to use large generators direct coupled to horizontal or vertical engines of the Corliss or marine type, and to use an equal number of generators and engines. In conclusion, they would like to express how greatly they were indebted to American street railway operators and electrical manufacturers for the uniform courtesy shown them, and the great pains so cheerfully taken to provide them with reliable information and data, and to the members of this Institution for the kind attention paid to their paper.

*Dr. du Riche Preller said he also must condense his remarks, and amplify them in writing. First, with regard to Mr. Lea's question as to the comparison between steam and electricity on rack railways. He had stated in a general way in his paper that according to his experience, and from all the other cases he had had occasion to investigate, the saving to be effected in electric traction, as compared with steam, might be taken as 50 per cent. That saving applied equally to steep grade lines, and to ordinary adhesion lines as well as to electric cable railways and to rack railways like the Mont Saleve line, near Geneva, and also the Barmen rack railway in Rhenish Prussia. With regard to this comparison between steam and electricity as concerning rack railways, he might refer Mr. Lea to a very careful comparison he had published in *Engineering*, early this year, between the Mont Saleve railway, which was electrically worked, and the Glion railway, which was also on the Lake Geneva, and which was steam worked. Those two railways presented very similar features. The length was about the same, the maximum grade of 25 per cent. was the same, and the number of passengers carried was about the same. The total working expenses on the Mont Saleve line amounted to 3·2s. per train mile, and on the steam line they amounted to exactly 6·5s. per train mile, so that represented exactly a saving of 50 per cent. As regards the remarks of Mr. Holroyd-Smith, and the section of trolley wheel that he exhibited, he failed to see how that trolley wheel with the extra groove could remove the disadvantages inherent to the fixed trolley wheel. It seemed to him that it would aggravate the evil rather than remove it, because in rounding curves they would have a grating strain on the edge of the groove. As regards the preference for the Buda-Pesth lateral slot system, he perfectly agreed with Mr. Smith that it was much better than the central slot. Mr. Parshall made some remarks about multiphase direct current, and he said that multiphase current seemed not to have very much prospect of success in electric traction. He (the speaker) did not agree with him, and indeed, Mr. Parshall told him afterwards that the Thomson-Houston Company were going to use three-phase current, transforming to direct current, on the Portland tramway in Oregon. That, it seemed to him, was an application of alternating current. It was a combination, it was true, of alternating and direct, but still the generating current was alternating. The only other remark he wished to make was with regard to what Mr. Robinson said about direct driving. He had taken care to have some statistics prepared of the Marseilles line, which was precisely a case in point, where the generators were first direct-driven by high speed vertical double-acting engines, which were afterwards replaced by engines of the Corliss type with rope driving. These had answered very well indeed, the economy in the consumption of fuel being very considerable. From another remark which Mr. Robinson made with regard to the question of steep grade lines not touching us in England so very closely, he entirely dissented, because without going into any question of elementary physical geography, he might say it was an absolute fallacy to suppose that there were no steep grades in this country. Leaving aside mountain railways properly speaking, such as the line up Snowdon would be, the first sod of which was to be turned within a day or so, there were plenty of steep grades all the way through from the Land's End and Dover right up to the Highlands of Scotland. He did not know if Mr. Robinson forgot that there was such a place as Hampstead Heath, where there was a steep grade of at least 1 in 12. Then in his own county, in the West Riding of Yorkshire, there was not a single town where they did not get a grade of 5, 6, and 8 per cent., *e.g.*, at Leeds, Bradford, Halifax, Huddersfield, Sheffield, and other towns. Moreover, many of the turnpike roads of this country were simply constructed on the old Roman roads, and everybody knew what the grades on the old Roman roads were. On the question of light railways in agricultural districts General Webber had spoken of electric lines costing £2,000 per mile and having a service of only two or three trains a day, the cost of such lines in this country would be at least £6,000, and it would be an absolute mistake to run only two or three trains a day in each direction. It was precisely the advantage of electric traction, according to his experience, that by running motor cars they could give people of a district the facility of communication every hour or every half hour; and in this connection he should like to recommend more especially one line in Switzerland which was opened last year, and was a very interesting and instructive case in point. It was a short electric tram-road from the Lake of Lucerne to a place called Stans. The width of the road was 20 feet, the gauge of the line laid on one side of the road was one metre (3·3 feet), and the rolling stock width was 6 feet 6 inches, so that they had 13½ feet left for the ordinary traffic. He put it to them which was preferable, to have traction engines running as they were allowed to run in this connection, or to have a road railway or tram-road on one side of the road, leaving a considerable width for the ordinary traffic? He thought there could not be any possible objection to this system, and the fact of there being thousands of miles on the Continent on this principle seemed to him a strong recommendation that such lines should be introduced in this country.

The president announced that the ballot for the council for the year 1895 had resulted as follows:—

PRESIDENT.

R. E. Crompton, M.Inst.C.E.

VICE-PRESIDENTS.

Sir David Salomons, Bart., M.A.	Prof. George Forbes, F.R.SS. (L. and E.).
Sir Henry Mance, C.I.E., M.Inst.C.E.	*Robert Kaye Gray, M.Inst.C.E.*

ORDINARY MEMBERS OF COUNCIL.

Major A. H. Bagnold, R.E.	Augustus Stroh.
Frank Bailey.	James Swinburne.
W. B. Esson.	*G. von Chauvin.*
Walter T. Goolden, M.A.	*S. Z. de Ferranti.*
Prof. A. B. W. Kennedy, LL.D., F.R.S., M.Inst.C.E.	*William E. Langdon.*
Prof. John Perry, D.Sc., F.R.S.	*Prof. S. P. Thompson, D.Sc., F.R.S.*

ASSOCIATE MEMBERS OF COUNCIL.

Augustus Calder.	*J. M. V. Money-Kent.*
Captain George Carr, R.E.	

The meeting was then adjourned until January 10th.

The Northern Society of Electrical Engineers.

DISCUSSION ON MR. GIBBINGS'S PAPER ON "THE COMMERCIAL POSSIBILITIES OF ACCUMULATORS FOR TRACTION PURPOSES."

MR. MANVILLE: I must congratulate Mr. Gibbings on his excellent paper. It has given me great pleasure in hearing it read, since it bears upon a subject of great interest to me, as I had the honour of escorting Mr. Gibbings and his committee over the only tramway system worked on the principle advocated by Mr. Gibbings in the United Kingdom. I feel a very special interest in the subject, as I have for a long time been endeavouring to persuade various local authorities to put up destructor plants in connection with central lighting stations. As long ago as 1892 I placed a complete scheme of this nature before the vestry of Shoreditch, who adopted the report, but so far have not carried it out. But I am pleased to say that since that time another important local authority, whom I am advising, has resolved to erect such plant, and I am in fact at present proceeding with the preparation of the plans and specifications for the carrying out of the work, and the scheme in question is almost directly similar to that referred to in Mr. Gibbings's paper, since it provides not only for the erection of a large electric generating station in combination with a dust destructor for electric lighting purposes, but also I have specific instructions to arrange the generating station so that the current produced by it may be easily utilised for supplying the tramways. I cannot agree with Mr. Gibbings as to the evils he states would result from the use of separate boilers in a destructor, from the remainder of the boilers required to make up the full maximum load required by the station; for in fact, in my opinion, there is no necessity for any boilers to be used, however large the load of the station, within wide limits, excepting those through which the hot gases from the destructor are passing; and in the scheme I have referred to, I am arranging for the erection of four boilers, each capable of evaporating water for 250 H.P., or a total of 1,000 H.P. Each boiler is arranged with two large destructor cells, one on each side of it, and the flues from the destructor cells are so arranged, that the gases pass underneath the tubes of the boilers immediately over the fire bars. Then, as at heavy load times, the gases from the destructor will be quite inadequate to raise the total amount of steam required, an extra amount of steam will be generated in the boilers by the addition of coal burnt on the fire grate of the boiler; thus, under these conditions, it will be seen that whilst all the gases from the destructor are used for the steam production to their fullest extent, the boilers can always be worked up to their full power by the burning of so much coal as will make up the difference. The fronts of the boilers, and the fronts of the two furnaces accompanying them, are so arranged on the same plan that they can all be attended to by the same body of stokers. I will not, however, dwell on the destructor portion of the question raised in Mr. Gibbings's paper, for in the main I am in hearty accord with him on the subject. I only regret, however, that he has taken, for example, a slow combustion destructor, such as that used by Mr. Jones at Ealing, as a typical furnace from which to generate steam. In such a furnace but a tithe of the power that might be realised is realised, and I have little hesitation in expressing the opinion that, with the quantity of refuse to be disposed of in Hull, in place of 45, Mr. Gibbings might rely upon attaining 120 effective H.P. on the average. I am afraid that I must seriously join issue with Mr. Gibbings as to the economical use of what I may term locomotive accumulators for running tramway cars. I am actually running the only system of locomotive accumulator traction in use in this country, and, as you all know, experience in such a matter is worth a great deal of theory, and I can only tell you that with all the care that is used in running this system, that with all the economy that is practised, that with all the facilities at my disposal for inducing economical working, we have never yet been able to even make ends meet, although receiving very high receipts per car mile; and I feel I must say that if there is anything unsatisfactory in tramcar running, it is the use of accumulators carried in tramcars themselves. The cost of running a tramway system in this manner under most circumstances is simply prohibitive. It is not, as I have often heard people say, the cost of the depreciation of the accumulator plates themselves. We have found that accumulator plates do not cost us more than 1¾d. per car mile, whereas our total cost of running exceeds 9d. per car mile; and if the expenditure directly due to the use of accumulators were eliminated from the system, that is to say, if the tramcars were run directly off conductors, overhead or underground, the cost would barely exceed 4½d. per car mile, so that if we add the cost of the renewal of the accumulator plates, 1¾d., to this 4½d., we get a total cost of 6¼d., and there still remains the large balance between this 6¼d. and, say, 9¼d., the actual cost of running, and this 3d. is absorbed in the extra cost of labour in handling the accumulators, cleaning them out, and so forth, and the extra depreciation of the car bodies due to the fumes from the accumulators, which, therefore, cost a great deal more to keep in repair than in a direct system. It must, therefore, be obvious to you all that if you had your accumulator plates costing actually nothing in themselves, the cost of handling them and making good the damage they do would prohibitively raise the cost above that of other systems, and from these figures you will get a good idea of the insignificance of the fuel question as compared with the other question. We find, as a matter of fact, that we use as nearly as may be a Board of Trade unit generated in the generating station for every car-mile run, and this Board of Trade unit does not cost more than 1·2d. to produce and, therefore, the energy used costs less than half the extra expense, in handling the accumulators, and repairing the cars. I fancy that this statement will clearly show you that we can hardly hope for satisfactory results from accumulators carried in the tramcars themselves, but I do not wish you to think for a moment that I am opposed to the use of accumulators in connection with a tramway system. On the contrary, I think they will become an integral part of every electric tramway system; but I would have them not carried in the tramcars themselves but used in the station, in which position they will last very well, and the heavy extra expense of charging and handling, and the repairing of the car bodies, will disappear, and there will also be the advantage of reducing the size of engines and dynamos, so that they will be working at their most economical load all day long, the accumulators making up those big peaks in the loads that in big tramway systems occur for a few minutes only at a time; and the whole generating system will be worked on a more satisfactory basis than heretofore. Such a system as this has been erected by Messrs. Mather & Platt in the Isle of Man, and is the first exemplification of what I believe to be the most important step in promoting the spread of electric tramways. Then, as regards the combination of a tramway station with an electric light station so as to place upon the latter that day load which will produce the marvellous decreased cost of current pointed out by Mr. Gibbings, surely these stationary accumulators will be at least applicable for this purpose as the locomotive accumulators. In connection with the local authority I have before mentioned, I have received instructions to lay out the electric lighting station in such a manner that the current it produces may be sold to the tramway company during 21 out of the 24 hours of the day to run their tramcars. It will be necessary for the tramway company to have a set of accumulators at their generating station large enough to run the whole of the tramway system during the time of the heavy load in the electric light station, but during the whole of the day and greater portion of the night the output of the electric light station will be available for directly running the tramways and charging accumulators. The generating plant of the tramway company will then consist of two or three motor generators transforming the current supplied from the electric lighting station to one suitable for running the tramway. One or more of these motor generators will be used during the daytime for directly supplying current to the tramway conductors, and the other for charging the battery of accumulators, and when the time of day arrives when the lighting station must cut off its supply of current to the tramway station, then the accumulators will be used for running the whole system. In this way I think the heavy day load may be given to the central lighting station, which will achieve Mr. Gibbings's results, and at the same time the tramway system may be run as efficiently as would be possible under any circumstances. I notice Mr. Gibbings lays stress on the fact that a low tension system can be more advantageously employed in the central lighting station if power is to be provided for the running of the tramways. In this point, also, I cannot agree with him, and I think all of you know that an alternating current motor, with continuous current generator attached, would make an almost ideal motor generator, when running in conjunction with accumulators from which the fields of the alternating current motor might so easily be magnetised, and I must therefore maintain that an alternating system of supply would be equally applicable with a continuous system for use in this connection. I will not take up any more of your time beyond again congratulating Mr. Gibbings on having brought before our notice a subject than which none can be more important to central station engineers, comprising, as it does, a means of reducing the cost of current for electric lighting, so that in most cities it could be supplied at a cost certainly lower than gas.

MR. FERRANTI: I have listened with the greatest possible interest to Mr. Gibbings's paper, and more especially to that part of it which refers to the combined use of central supply stations for doing the ordinary lighting and charging of batteries for power purposes. The picture which Mr. Gibbings has drawn of the great advantages which may result from such an arrangement makes one feel quite pleased with the great economic possibilities in this direction; but on the other hand, we have just heard that Mr. Manville has found it practically impossible to make ends meet upon a complete system of electrical traction by storage, and no matter how cheaply the current may be produced by the method which Mr. Gibbings has described, that it is impossible to do anything very satisfactory upon this plan. Apparently the cost of handling and maintaining the batteries comes to nearly as much per car mile as the total cost of working an overhead system, and therefore even if Mr. Gibbings got his electricity for nothing for charging the batteries, according to the information which we have had laid before us, it does not look as though it would be of any value. Of course, improvements will no doubt be made,

but they will have to be very vital ones before this trouble can be got over. Assuming, however, that traction by batteries could be worked commercially if the batteries were charged by current cheaply obtained from the lighting station, you would then have to remember that the plant at the lighting station could only be relied upon for a short number of hours out of the 24, as you would have to leave sufficient margin for the continuous heavy load which is experienced on a few days in the winter of every year. If it were not for this difficulty, no doubt the use of batteries for assisting ordinary supply stations would have been very largely gone in for; but practice appears to have shown that the cheapest thing which we are able to do up till now is to generate the electricity by dynamos as it is required.

Mr. Holroyd Smith said he was very glad to be present at the meeting, and first of all wished to compliment them on having banded themselves together and formed that society, which was evidence that they meant to confer one with another, not helping their individual selves only, and he gave his heartiest wishes to the Northern Society of Electrical Engineers. Some things had been said, and better said, perhaps, than he could say them, by Mr. Ferranti and Mr. Manville, but there is just one little point in the early part of the paper, namely, with regard to interested experts. I am afraid that I cannot claim to be anything else than an interested expert, and, further, I do not think that Mr. Manville can, and I am afraid that Mr. Ferranti is also one. Perhaps, when I sit down, the chairman will be able to call upon someone who is *not* an interested expert. I may say that this is the first time in the whole of my experience, although I have been looking for it for a long time, that I have heard a straightforward expression with regard to the cost of working tramcars by means of accumulators. I have seen statement after statement put out to the world which, after falling into the hands of the public, not interested experts, have created an impression not altogether reliable, but Mr. Manville has been very frank in giving us a few figures as to cost per car, &c., confirming, nay, even going beyond the statements I have from time to time made, based on calculations and careful observation of what others have done; for I fully admit that in battery traction I have been content to profit by the experience of others. I have not wasted time and money on experiments that I felt sure could not yield economic results. If accumulators had shown any possibilty of their being really better than the other systems, I should have adopted them long ago. But there is one thing which I should like to protest against, namely (the hope has so far been father to the thought), that statements have gone out from interested experts in the electrical world that have been readily taken up by the outside world, and have led tramway directors, town councillors and others, to suppose that batteries about the size of a hat were going to be placed under the seats of a car and drive it all day long; and this has got such a firm hold in the public mind, that it has been a serious hindrance to the progress of electric traction. This paper must be a very interesting one to this Society, because it opens for discussion the debatable question of alternate *versus* direct current for electric lighting stations. It must be interesting to town councillors, giving them difficult questions to digest respecting corporate economy. I will not venture to traverse over all the ground; Mr. Gibbings has shown considerable skill in doing so, holding out many hopes, but committing himself to very little. He might have been practising at elections for Parliamentary honours. Mr. Smith then passed on with a few remarks with reference to the ten points which Mr. Gibbings raised in his paper about the disadvantages of the direct driving system, taking these *seriatim*. He pointed out that the irregular demands upon the generating plant were not so severe and not so detrimental as the reader of the paper would have us to believe, and ventured to contradict a few of the other so-called disadvantages, especially that the wear and tear with batteries would be less than with direct driving, for when it was known that the weight of the batteries equalled the weight of the car (for example, a 3-ton car required 3 tons of batteries to drive it), then it was obvious that the wear and tear with batteries must be greater, not less, as stated in the paper. He suggested that Mr. Gibbings ought to have given them a definite tramway, stating the number of cars, hours of working, length of line, &c., and fully worked out his figures, showing cost of equipment and working. There would then have been something definite to work with.

Mr. John Hesketh congratulated Mr. Gibbings on uttering what they believed to be the cry from all central stations: "For goodness sake give us a day load; we want it, and if we can get it by accumulators let us get it, but by all means let us have a day load." Some people say, "at whatever cost." He thought that, taken on that view, the scheme proposed by Mr. Gibbings an excellent one, but taking other circumstances into account, he was afraid he could not agree with him. He had had the pleasure of seeing one of the principal lines on the Continent worked on the accumulator system, and he at the time wondered how it was that with accumulators of the certainly excellent type which they had, and with the skilled staff and every possible modern convenience, they should still make a loss; but he did not wonder long, for when he got to the station he found one large group of men attending to batteries, another group attending to repairs, and still another attending to cars, &c.; altogether he should say there were about 100 men in the station at that time charging and attending to batteries, &c., for 20 cars. One had not to look far for additional expense, and he therefore did not agree that the running expenses in connection with the accumulator traction were in any way on the same lines as the direct system. Mr. Smith, he believed, asked for some figures in reference to comparative capital costs, and he was pleased to be able to give these. He had got out schemes for running a line on the overhead, conduit and accumulator systems, based on the same footing, and had found that the accumulator plant cost £5,000 more in capital outlay than the other two, and he therefore thought that the point raised by Mr. Gibbings was scarcely borne out.

Mr. A. Lester-Taylor stated that with regard to the Board of Trade regulations and fire office requirements, referred to in the paper as being very stringent, in New York they were practically prohibited from using current for traction purposes in connection with other systems, or rather that no systems may be supplied from these trolley wires.

Mr. Gibbings, in reply, mentioned that the system which he had set forth and advocated in his paper was simply that which had appeared to him to be most advantageous to the town of Hull, that is to say, that he had found the conditions in Hull peculiarly suited to that particular kind of traction on account of the level roads and the situation of the central electric lighting station. He did not mean to say that very much profit would be likely to accrue to the tramway enterprise at the present time, but matters were certainly progressing in the direction of the improvement of accumulators, but the great advantage which would arise would be from the electric lighting enterprise, because the price could be so reduced that there would be a great many more people who would be induced to go in for the electric light. Of course we have to decide every case on its own merits. He might mention that Mr. Manville misunderstood his remarks with regard to separate boilers. He did not mean different sets of boilers would have to be employed at the destructor station for the destruction of refuse and generating electrical energy respectively, but the boilers at the destructor station were distinct from those at the electric lighting station. With reference to the Birmingham Electric Tramway, this was the only instance in this country of accumulator traction on a large scale, and they had therefore no other place with which a comparison could be made. In reply to Mr. Ferranti, Mr. Gibbings said that he had already stated in the paper that his remarks were rather in the abstract than in the concrete, and therefore the possibilities set forth in the paper would of course only hold good where conditions and circumstances were favourable. In reply to Mr. Holroyd Smith, he had not meant the remarks which he had made with reference to electrical experts to be taken in any disparaging sense. Of course, there was no reason why experts should not be given full credit for their own recommendations when electric tramcars were dealt with as a single and independent concern. With regard to giving figures of an ideal example of such a combination, it had not been his intention in this paper to go into complete details such as total capital expenditure, interest, or depreciation, but simply to give a few suggestions on the subject. He considered Mr. Holroyd Smith's remarks about "parliamentary honours" entirely irrelevant. He was not a debater, but when he had an opportunity of sitting down and putting his ideas in writing, he endeavoured to do so to the best of his ability, and with an open mind. To Mr. Hesketh's remarks as to the line which he saw on the Continent, while they did not have much bearing upon the combination suggested in the paper, he would point out that Mr. Hesketh's observations were antithetical to the Rev. Laurence Sterne's, inasmuch as this was one of those things which they did *not* manage better in France than at Birmingham. He had no further remarks to make upon observations that had been made that evening, but if this paper would lead to further enterprise and experiment, either in the direction in which Mr. Manville or himself had pointed out, he would be amply rewarded. He did not want them to take that paper as a definite scheme which he advocated in its entirety, or as coming from an expert on the subject, but, as before stated, merely one with suggestions and possibilities thrown out, and which, if acted upon under fair conditions, he would look forward to with no misgiving as to the result.

The chairman, Mr. Fawcus, wished to propose a vote of thanks to Mr. Gibbings for his paper. It had been the means of promoting a very good discussion, and they had been glad to see amongst them some of their great *provincial* members. He thought that the matter which Mr. Gibbings had brought before them was one on which there was a great difference of opinion, but one which was certainly worthy of consideration, especially with a view to increasing day loads on central stations.

NEW PATENTS—1894.

23,970. "Improvements in electric conductor supports." A. Anderson and J. M. Anderson. Dated December 10th. *Complete.*

23,980. "Improvements in sentinel electrical alarms." A. M Morin. Dated December 10th.

23,988. "Improvements in electric lighting devices." R. W. Inman. Dated December 10th.

24,002. "Improvements in the manufacture of armatures for electric bells." I. H. Parsons. Dated December 10th.

24,021. "Combined terminal box and cut-out or fuse box." W D. Reid. Dated December 11th. *Complete.*

24,067. "Improvements in organs, harmoniums, and similar instruments." R. Hope-Jones. Dated December 11th.

24,075. "Improvements in regulating electric dynamos and motors." T. D. Hollick and F. W. Hollick. Dated December 11th.

24,076. "Improvements in and relating to telegraphic transmitting and receiving apparatus." B. Hoffmann. Dated December 11th.

24,098. "Improved contruction of joints and connections for metallic tubular structures, such as are used for the underframes of railway carriages and waggons, girders and frames for bridges and buildings, and for tubular poles for electrical conductors, for masts, railings, and the like." G. E. Church and G. W. Ettenger. Dated December 11th.

24,136. "An improved reversible switch wall-socket and plug." W. J. Fryer. Dated December 12th.

24,173. "Improvements in and relating to electric motors and to the distribution of electric energy." H. H. Lake. (Communicated by H. Gutmann, Germany.) Dated December 12th.

24,194. "Multiple electric fuse box." E. A. Parson and H. Millar. Dated December 12th.

24,195. "A mode of controlling magnetic energy." H. M. Paine and A. R. Brandly. Dated December 12th. (*Complete.*)

24,198. "Improvements in electrical resistances and in processes for rendering inert or electrically non-conductive substances electrically conductive." A. J. Marquand, E. Hancock, and D. Lowdon. Dated December 12th.

24,234. "Reflectors for electric lighting." P. Korber. Dated December 13th. (*Complete.*)

24,266. "Improvements in apparatus for starting alternating current electro-motors." A. Bergtheil and R. A. Marples. Dated December 13th.

24,285. "Improvements in and connected with electric systems for lighting of trains and for other purposes." A. G. New and A. J. Mayne. Dated December 13th.

24,291. "Improved means for securing the terminal wires to carbon and other electrodes." F. A. von Alimonda and N. von Alimonda. Dated December 13th.

24,293. "Improvements in apparatus for determining the mechanical equivalent of heat." W. E. Ayrton and H. C. Haycraft. Dated December 14th.

24,297. "An improved porous cell for an electric generator or battery." W. McChleary. Dated December 14th.

24,310. "Producing disinfectants and antiseptics by ozone." E. Andreoli. Dated December 14th. (*Complete.*) [Date applied for under Patents, &c., Act 1883, Sec. 103, 16th May, 1894, being date of application in Belgium.]

24,353. "Improvements in brackets for poles or standards for electrical conductors and similar purposes." Siemens Bros. & Co., Ltd. and G. W. Perry. Dated December 14th.

24,369. "Improvements in or appertaining to electric bells or alarms." J. T. Brierley. Dated December 14th.

24,372. "Improvements in shade holders for gas, electric, and other lamps." S. Sinauer. (Communicated by the Utility Shade Company, United States.) Dated December 14th.

24,374. "Improvements in the insulation of electric wires or cables." F. Clouth. Dated December 14th. (*Complete.*)

24,385. "Improvements in electric supply meters." J. Perry. Dated December 15th.

24,431. "An improvement in tubular posts for telegraphic and other purposes." Siemens Bros. & Co., Ltd., and G. W. Perry. Dated December 15th. (*Complete.*)

24,440. "Improvements in devices for joining or conducting telegraph and telephone wires, and for other purposes." W. B. Shaw. Dated December 15th.

24,441. "Method and apparatus for preventing sparks in electrical apparatus." W. F. Ostwald. Dated December 15th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1893.

20,698. "Improvements in and in connection with electric cables." G. G. M. Hardingham. (A communication from the firm of Felten and Guilleaume, of Mülheim-on-the-Rhine.) Dated November 1st. In a cable constructed according to this invention, there is combined with the main conductor an additional or "safety" conductor, made of less ductile metal than the main conductor. 4 claims.

21,631. "Improvements in electrolytic apparatus." W. H. Caldwell. Dated November 13th. Relates to a diaphragm formed of loose crystals of the salt which is being electrolysed. 1 claim.

21,752. "Improvements in crimping, bending, or shaping and holding wire or other forms of metal, and in the means or apparatus employed therein." R. E. B. Crompton and H. J. Dowsing. Dated November 14th. Has for its object to effect the crimping, or bending or shaping of wire, tape, band, or sheet metal, into any desired form, and in some cases to aid in the holding or fixing of the same in the shape produced upon a holder or fixing surface. 4 claims.

23,074. "Improvements in electrical switches." W. P. Theermann. Dated December 1st. The object of the invention is to make a lamp switch, simple in construction, reliable in its action, and to be able to switch the current on or off by the use of two fingers only. 2 claims.

23,327. "Improvements in electric lamp fittings." A. J. Howes. Dated December 5th. Has for its objects the production of a standard pendant, or side bracket, which may be lengthened or contracted at will, without the employment of chains, weights, or other cumbrous counterbalances, and is also capable of lateral movement in any direction. 2 claims.

24,081. "Improvements in the manufacture of carbon for electric lighting and other electrical purposes." R. Niewerth. Dated December 14th. Claims:—1. In the manufacture of carbon for eliminating resistance; heating the carbons after moulding, by means of an electric current in place of baking, as and for the purposes set forth. 2. During the heating of the carbon by electricity, supporting the carbon in a holding sleeve of non-conducting material to prevent warping. 3. Adding a metallic compound to the material from which such carbons are produced for the purpose of eliminating resistances, and raising the conducting capacity of the same; said metallic compound being reduced when the carbon is subsequently raised to red-heat, as described.

24,217. "Improvements in electrical measuring instruments and apparatus for use with alternating currents." W. E. Ayrton and T. E. Mather. Dated December 16th. Relates, firstly, to methods of applying voltmeters to indicate the pressure between mains at a distance from the instrument without the use of pilot wires; and secondly, to apparatus for showing the current flowing through a circuit or circuits, which may or may not be at a distance from the measuring instrument. 3 claims.

24,276. "Improvements in apparatus for electrolytic purposes." H. Guthrie. Dated December 16th. Apparatus according to this invention is constructed mainly of sheet or flat material, cut or stamped out or otherwise shaped and laid together so as to form the anodes and cathodes, the chambers for the electrolyte and collection of gas, the feed and exit ducts for brine and solution of caustic soda respectively, the chlorine and hydrogen ducts, the electrical connections and insulators, and the diaphragm dividing the cathode chamber from the anode chamber. 3 claims.

24,285. "Improvements in means for connecting or supporting electroliers, brackets for electric lamps, or the like, to or from ceilings, walls, or other places of support. H. Edmunds. Dated December 16th. The inventor provides at the part of the ceiling, or wall, or other place, to which the fitting is to be attached, a holder, or supporting piece, provided with a fastening device for the mechanical connection of the electrolier, or the like, and with contact pieces in connection with the lead wires for the electric current. The electrolier, or the like, is provided with a corresponding fastening device for the connection of the electrolier, or the like, and with corresponding contact pieces to which the wires leading to and from, the lamp, or lamps, are connected, the arrangement being such, that, as the parts for the mechanical connection are being secured together, the respective contact pieces are also brought together, and the mechanical and electrical connection simultaneously effected. 2 claims.

24,353. "A new or improved preparation of active material for electric accumulators." C. K. Mills. (A communication from C. J. Barbier, of Lyons.) Dated December 18th. Consists in the employment of lead, divided or separated by special means, to replace the minium or other oxides of lead generally employed in the construction of accumulators. The lead is divided or separated by pulverisation in a molten state, either by allowing it to fall in one or more jets on to the plates or floats of a quickly revolving wheel, or under the action of a current of compressed air or steam acting upon it at the mouth of an orifice as in ordinary pulverisers. 2 claims.

24,389. "Improvements in electrode plates for secondary batteries." Dr. A. Lehmann. Dated December 19th. The plate or grating which is inserted in the frame of the electrode is so made or corrugated that it forms a double series of horizontal, or nearly horizontal, channels or gutters, one series on the one side and the other series on the other side. The active substance is placed in these channel-shaped receptacles. 1 claim.

24,442. "A new or improved electrical accumulator plate." C. K. Mills. (A communication from C. J. Barbier, of Lyons.) Dated December 19th. The plate is composed of a flattened box formed of two sheets of lead, the edges of which, raised in double curves and juxtaposed, are riveted or soldered all along their circumference. The flat sides of this box are provided interiorly with pins cast in one with them, and the ends of which reach almost to the opposite side; these pins or projections are arranged on each side so as to come between each other at regular distances. The sides are besides pierced with holes, arranged between the pins or projections, and in such a way that the extremity of each pin is located in line with one of the holes of the opposite side. Before soldering or riveting the box around its edges the active material is introduced conveniently rammed or compressed, which is divided and maintained in position by the pins or projections which traverse it at all parts. 2 claims.

24,606. "Improvements in the means of suspending arc and other electric lamps and fittings." E. A. Claremont. Dated December 21st. The object of the invention is to enable the lamps to be lowered for inspection from any of the said elevated positions without requiring the connecting wires to be of the length corresponding to the distance of the lamp from the ground, and thereby hang in loops or festoons when the lamp is in use. 3 claims.

24,889. "Improvements in connection with phonographs, graphophones, and similar sound recording and reproducing machines." J. L. Young. Dated December 27th. Relates to the manner of mounting the guide arm of the reproducing stylus; also to the manner of mounting the cutting or recording stylus and the reproducing stylus; also to the mounting of the detachable portion upon the speaker arm in such a manner that this may be capable of being rotated thereon in either a right or left handed direction to the extent of one half turn, or thereabouts; also to a method of mounting two diaphragms, diametrically opposite to each other, upon the said detachable portion, mounted upon the speaker arm, so as to be capable of rotation thereon to the extent of one half turn. 5 claims.

24,979. "Improvements in instruments for measuring and recording electric pressures and currents." W. Thomson (Baron Kelvin). Dated December 29th. To increase the power of the cellular or multi-cellular pattern described in patent No. 18,035, 1888, the inventor uses for the movable body three vanes, or three sets of vanes, fixed in corresponding positions at angles of 120° round an axis. 3 claims.

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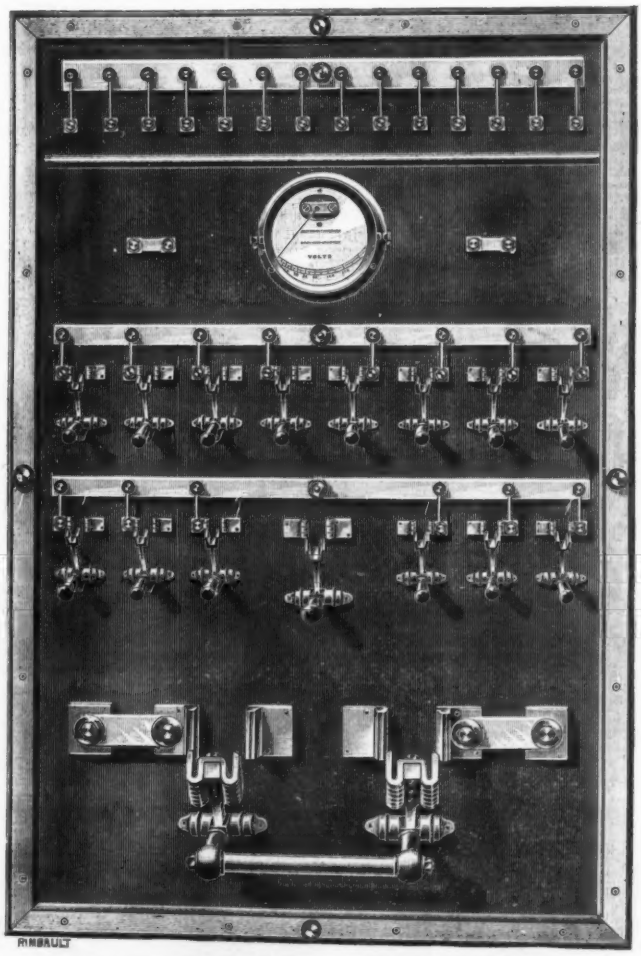

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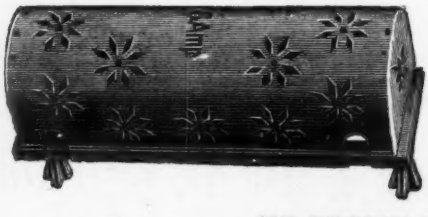

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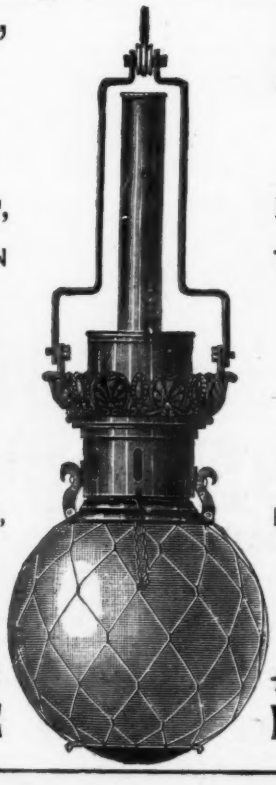

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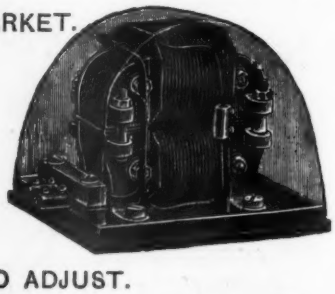

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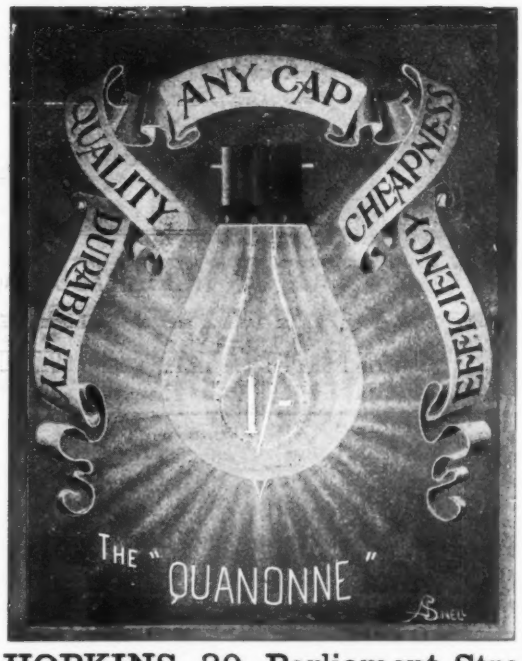

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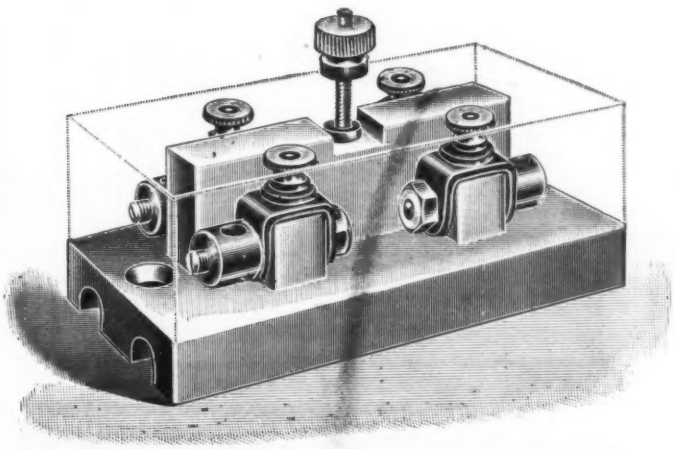

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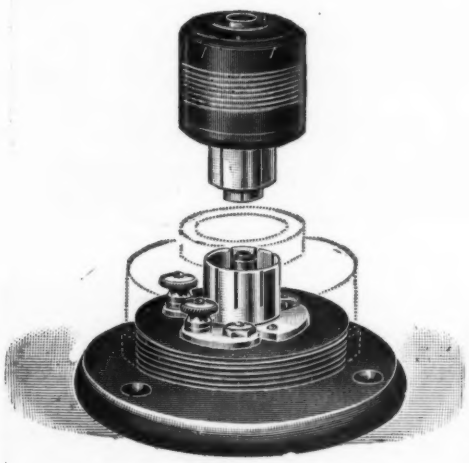

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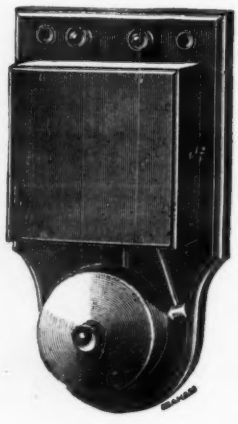

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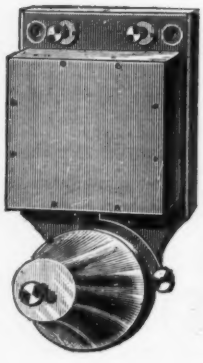

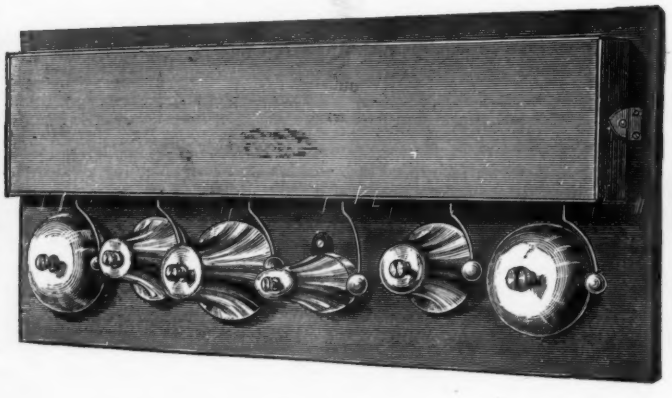

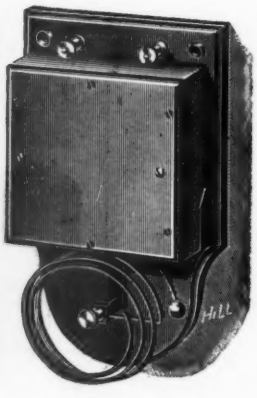

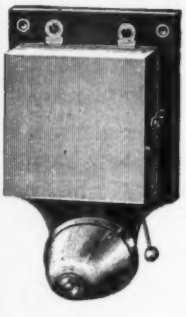

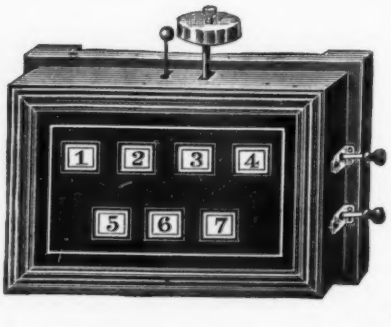

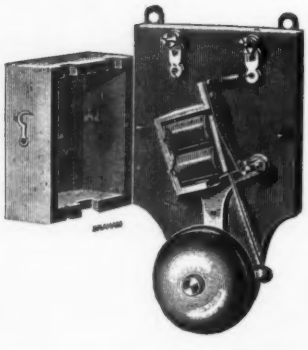

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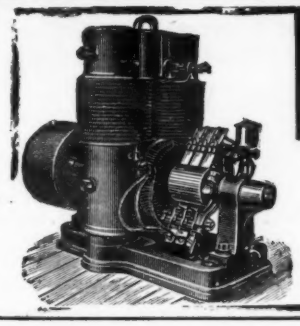

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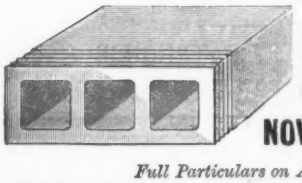

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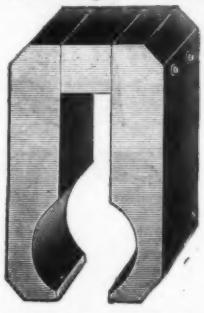

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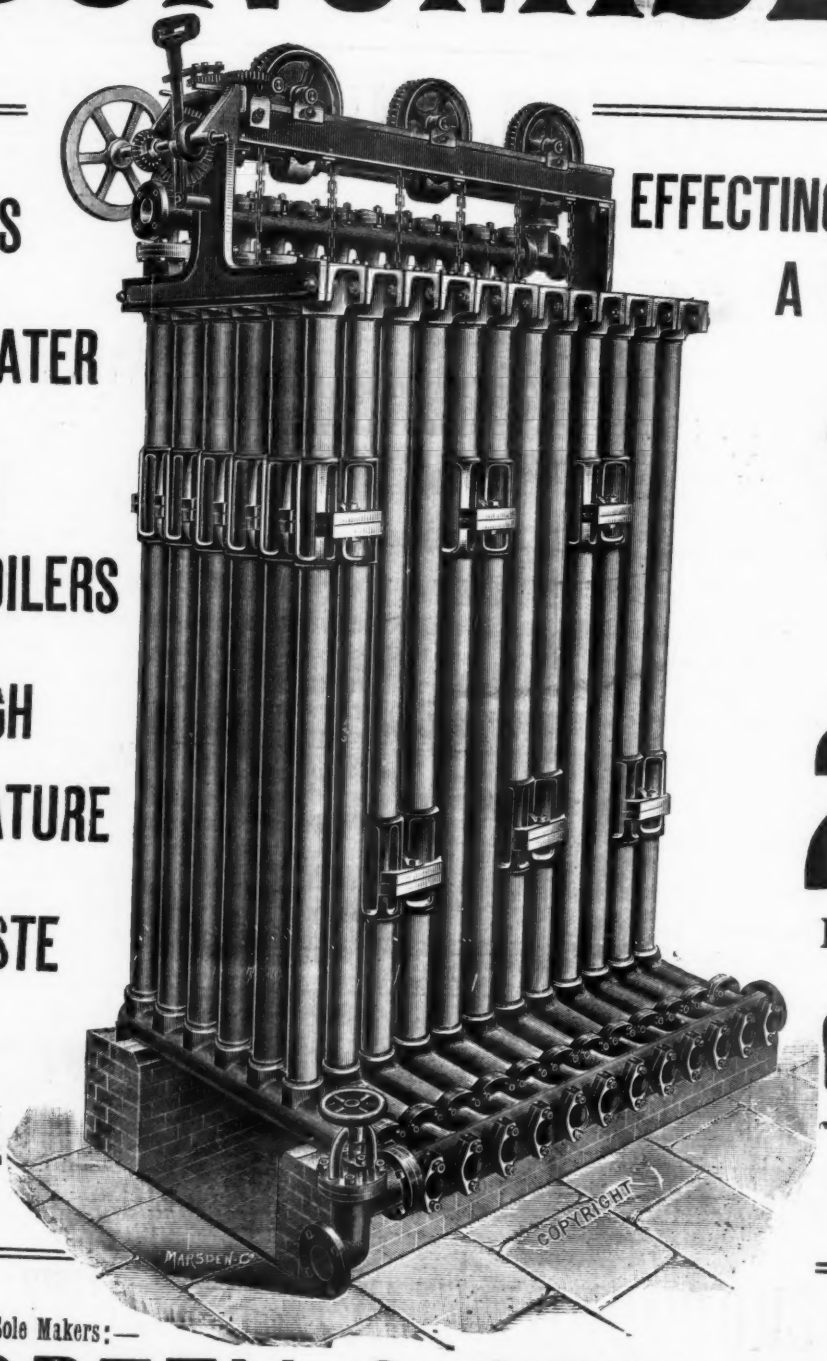

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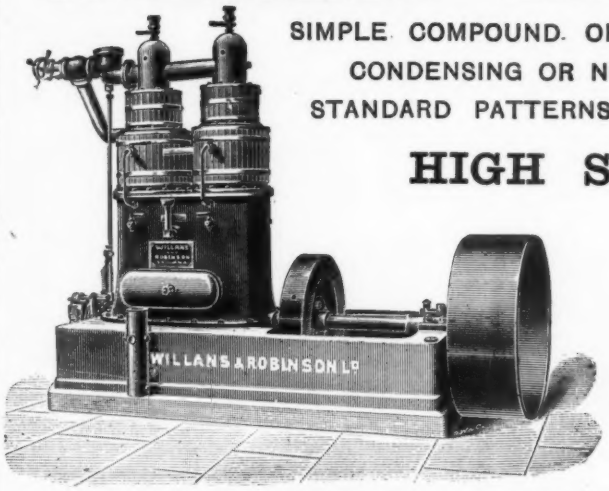

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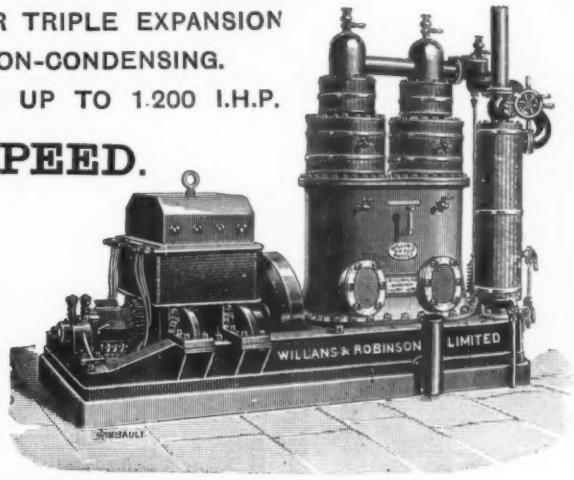

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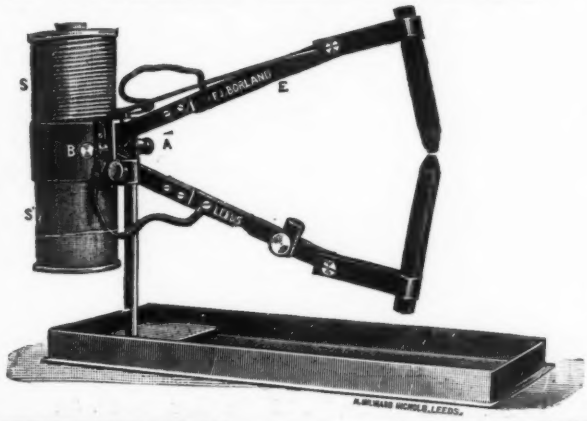

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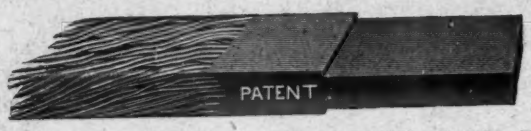

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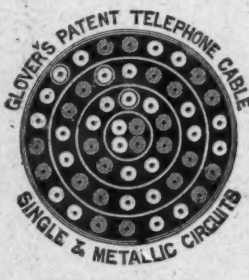

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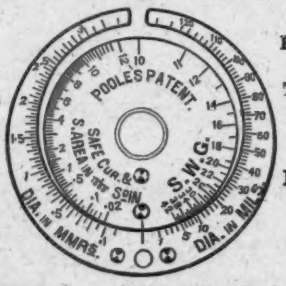

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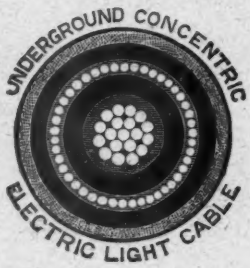

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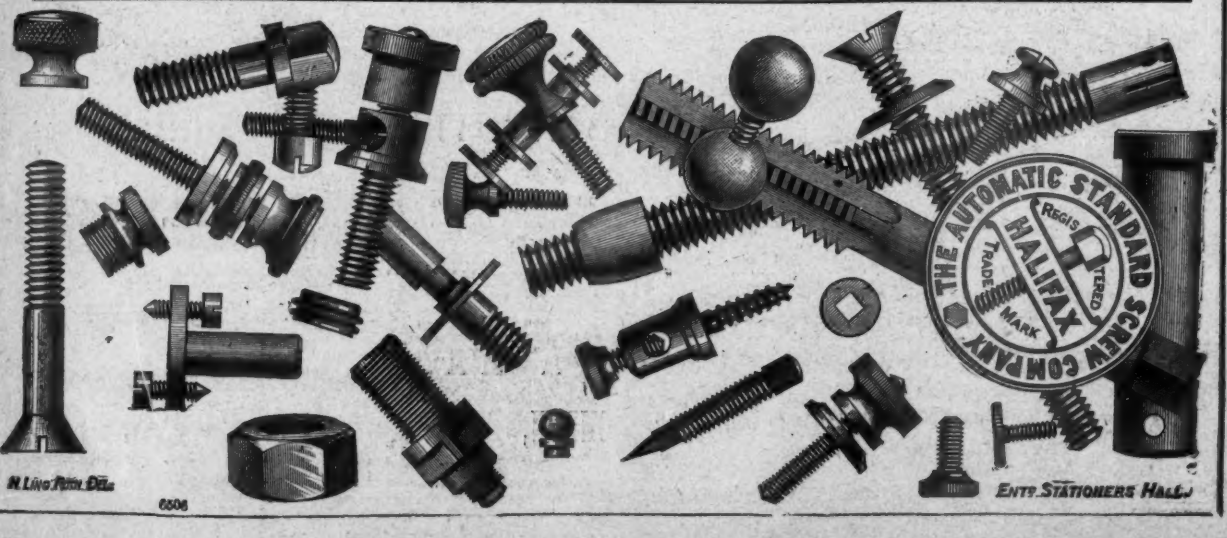

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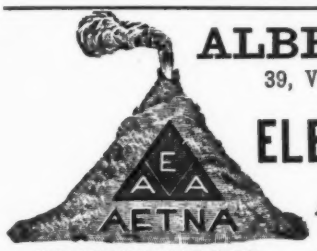

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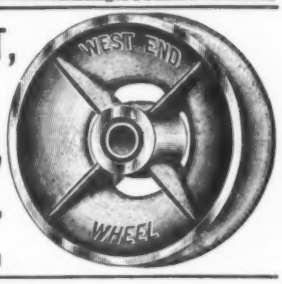

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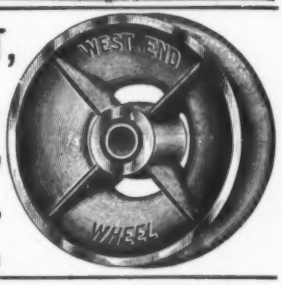

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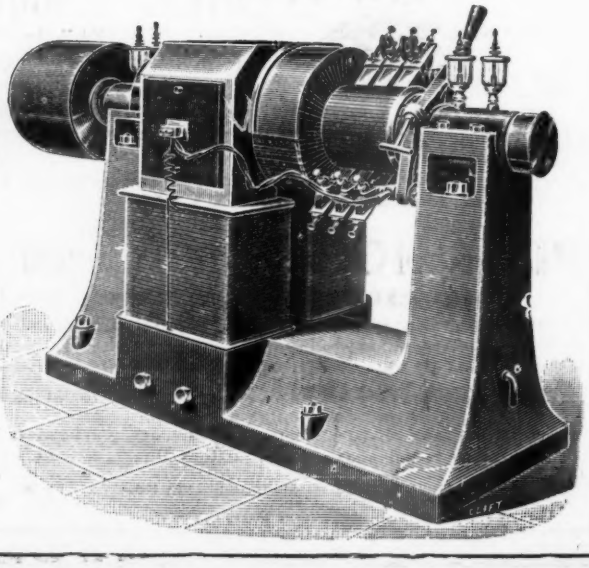

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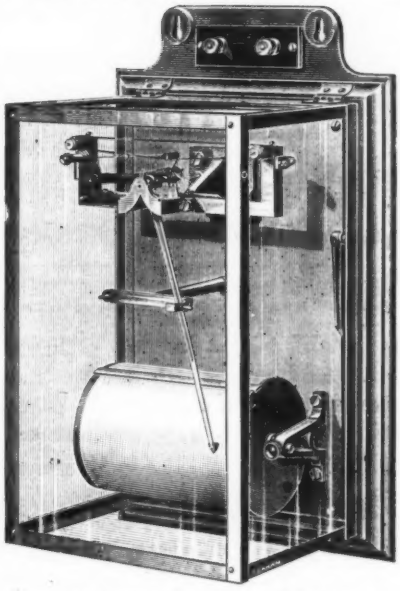

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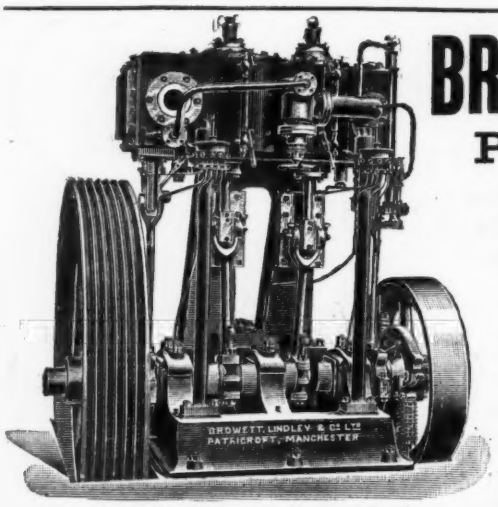

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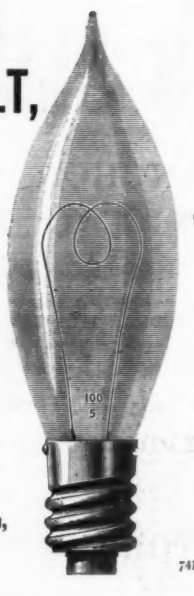

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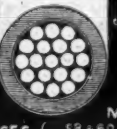

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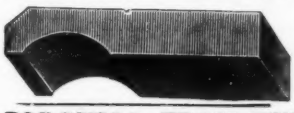

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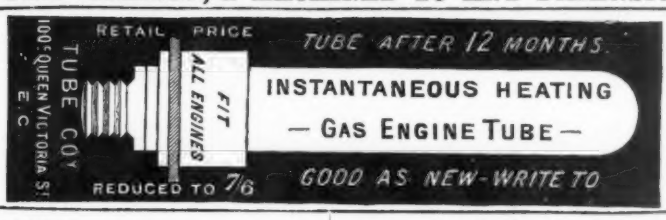

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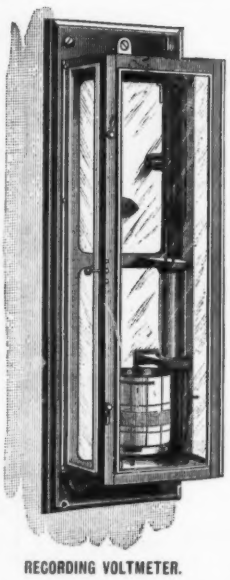

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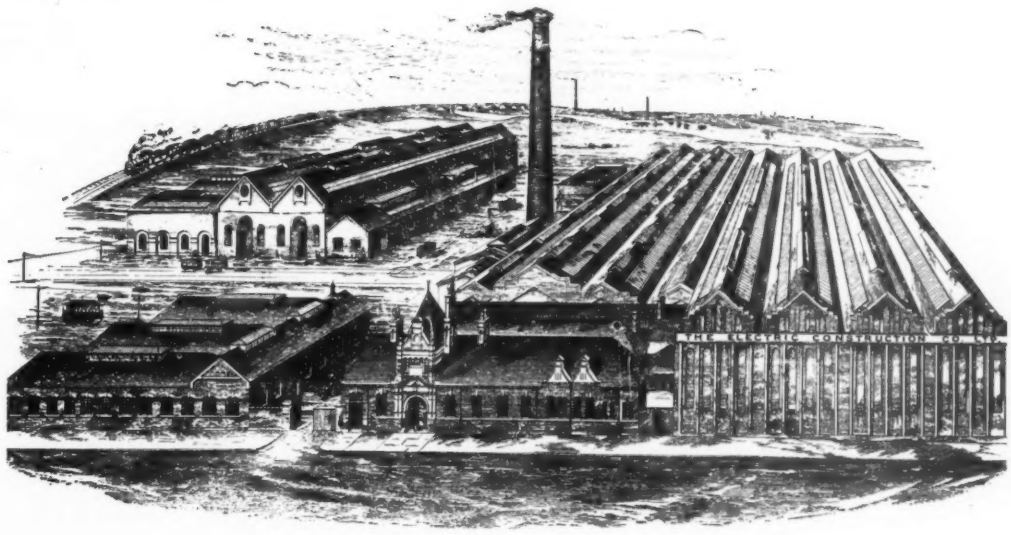

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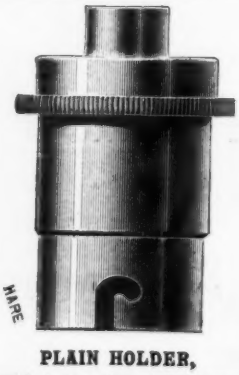

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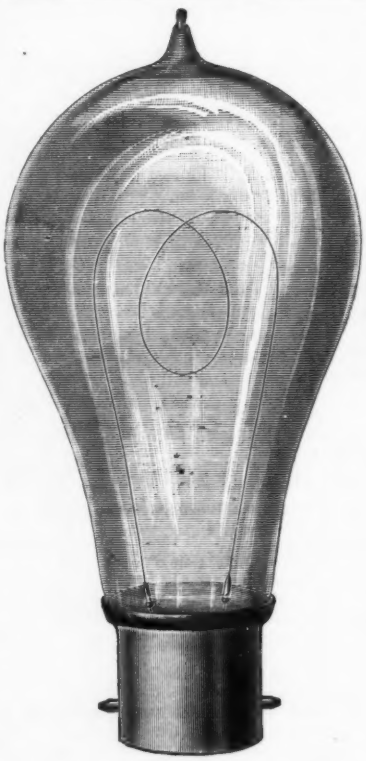

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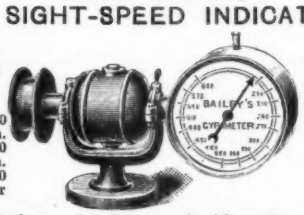

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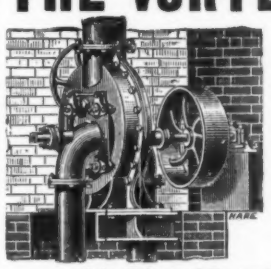

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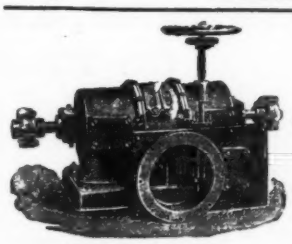

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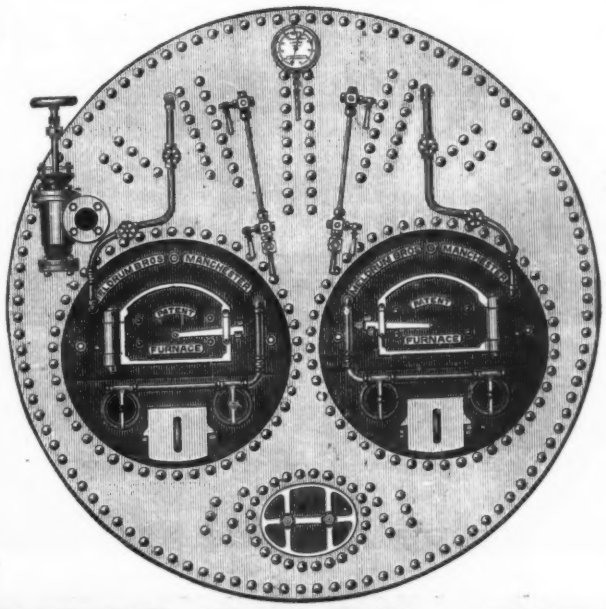

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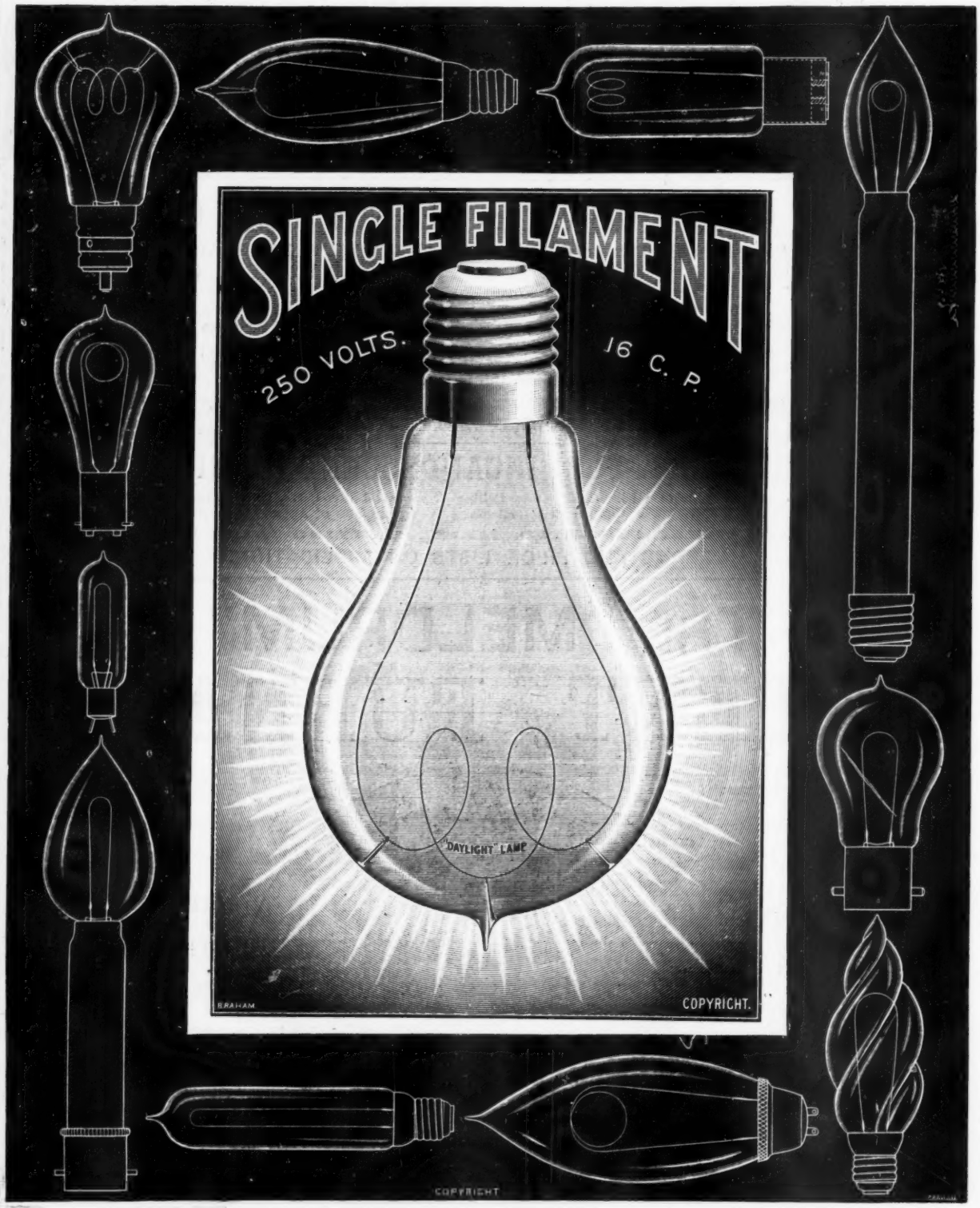

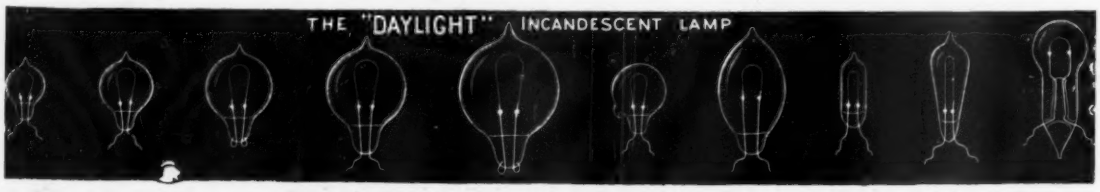

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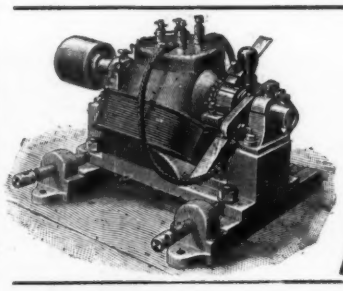

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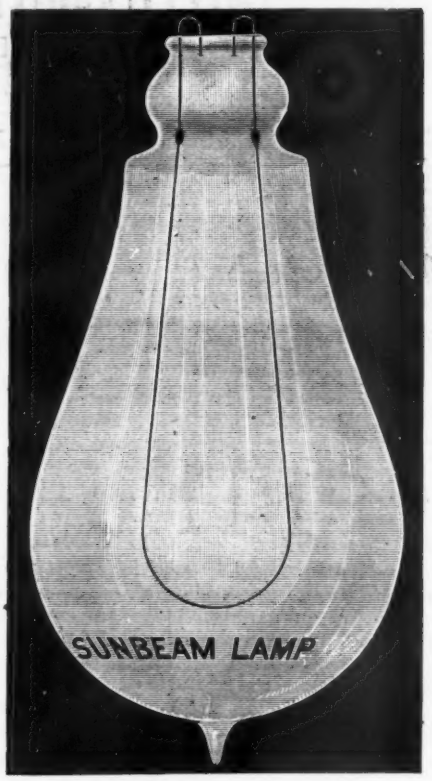

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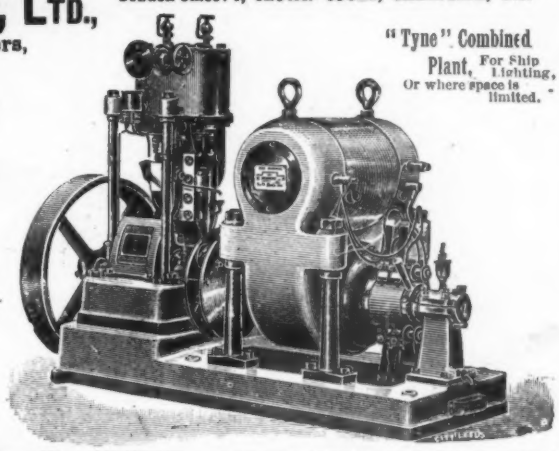

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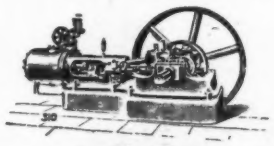

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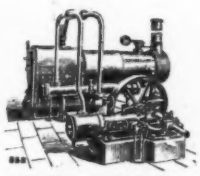

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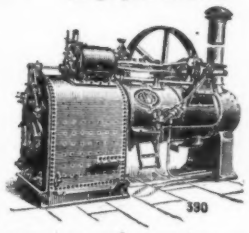

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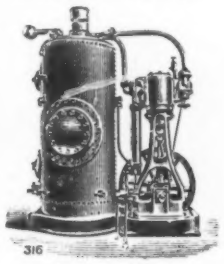

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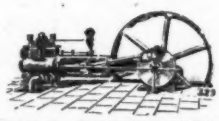

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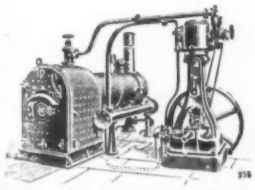

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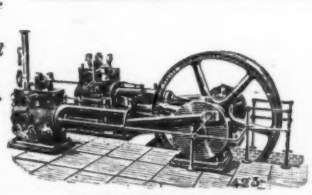

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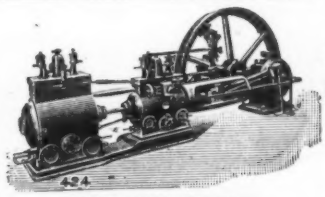

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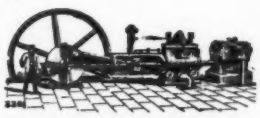

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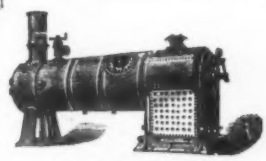

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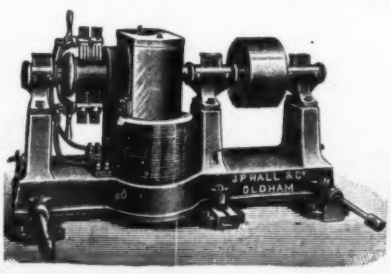

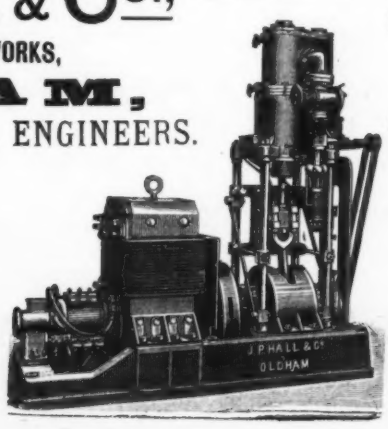

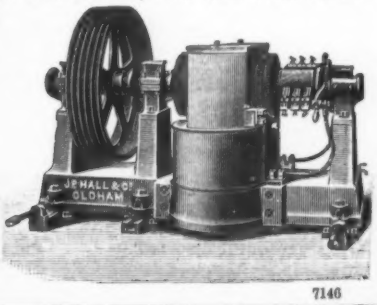

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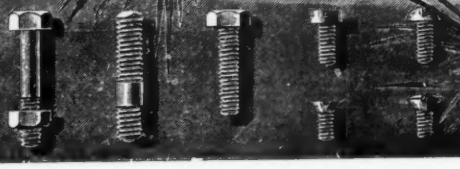

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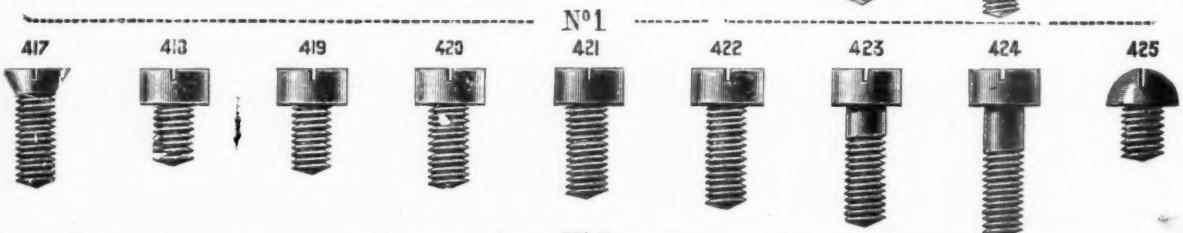

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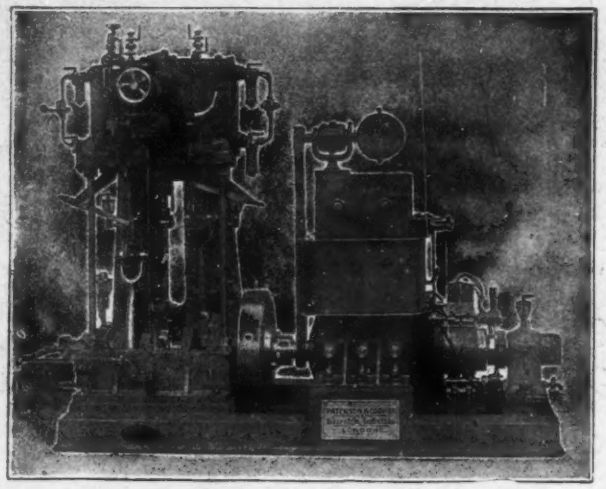

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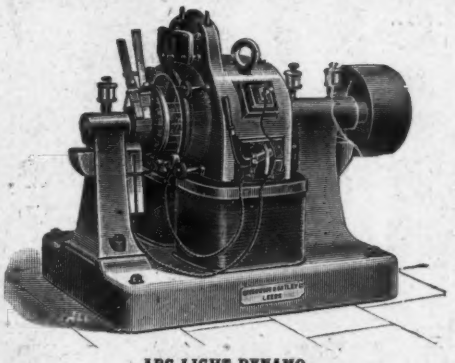

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Printed by E. Knight, 18 and 19, Middle Street, E.C., and Published by the Proprietors, H. Alabaster, Gatehouse & Co., at 23, Paternoster Row, London